KNOWLEDGE
AN
ILLUSTRATED MAGAZINE
OF
SCIENCE, LITERATURE & ART.

*LONDON: SEPTEMBER 1, 1896.*

## CONTENTS.

| | PAGE |
|---|---|
| Waves.—IX. Notes on Sound Waves. By VAUGHAN CORNISH, M.Sc. (*Illustrated*) ... ... ... ... | 193 |
| Linoleum. By Dr. GEORGE MCGOWAN ... ... ... | 195 |
| The Sooty or Brown Albatross. (*Plate*) ... ... ... | 196 |
| The Causes of Colour. By J. J. STEWART, B.A.Cantab., B.Sc.Lond. ... ... ... ... ... ... ... | 197 |
| Microscopy. By A. B. STEELE ... ... ... ... | 199 |
| A Quarter of a Century's Work on Respiration. By C. F. TOWNSEND, F.C.S. (*Illustrated*) ... ... ... | 200 |
| The Rev. Francis Wollaston, Amateur Astronomer. By W. T. LYNN, B.A., F.R.A.S. ... ... ... ... | 202 |
| The Total Eclipse of August 9, 1896. By E. WALTER MAUNDER, F.R.A.S. ... ... ... ... ... ... | 203 |
| Extended Nebulosity round Antares. By Prof. E. E. BARNARD, F.R.A.S. (*Plate*)... ... ... ... ... | 205 |
| Notices of Books. (*Illustrated*) ... ... ... ... | 205 |
| Letters:—G. H. HILL; H. A. COOKSON; R. J. D. SAIR ... | 207 |
| Some Curious Facts in Plant Distribution.—IV. By W. BOTTING HEMSLEY, F.R.S. ... ... ... ... | 208 |
| Emery. By RICHARD BEYNON ... ... ... ... ... | 210 |
| A Crocodile Mummy in the British Museum. By H. SPENCER ... ... ... ... ... ... ... | 210 |
| Some Notes on Spiders. By Rev. SAMUEL BARBER ... | 211 |
| The Affinities of Flowers.—The Harebell and the Daisy. By FELIX OSWALD, B.A.Lond. (*Illustrated*) ... | 212 |
| The Face of the Sky for September. By HERBERT SADLER, F.R.A.S. ... ... ... ... ... ... ... | 215 |
| Chess Column. By C. D. LOCOCK, B.A.Oxon. ... ... | 215 |

## WAVES.—IX.

### NOTES ON SOUND WAVES.

By VAUGHAN CORNISH, M.Sc.

WE leave for the present the waves of water in order to apply our study of the wave patterns given by moving bodies to the study of the physical properties of sound waves in air.

By means of the electric spark it is possible to see a noise. The arrow-headed wave front in Fig. 1 is the photograph of the hum of a bullet. The bullet completes an electric circuit when it brushes by the two wires shown in the figure, a spark illuminates the chamber through which the bullet is passing, and the phenomena may either be photographed by the light of the spark, or the whole thing can be seen if the eye be placed in the position of the photographic plate. The wave pattern is simpler than that formed in front of a small floating body; it is as if all the ridges and hollows of the water pattern had been omitted except the ridge of the wave of minimum velocity—that nearest the body. The single wave formed in front of a flying bullet is a wave of compressed air, as is shown by the fact that it appears dark. The light comes from the further side of the bullet, and where it meets this denser air at a grazing angle is deflected from its path, leaving a dark line. The bright line behind it is believed to be due simply to the fact that this part of the photographic plate is illuminated both by the light which passes straight through the place and by the light deflected from the condensed air. The velocity of the free wave of compressed air can be determined from the angle of the cone, the velocity of the bullet being known. With a Martini bullet (Fig. 1) the apex of the cone advances one thousand three hundred feet, while the wave has spread laterally one thousand one hundred feet on each side. The velocity of the free wave is therefore not one thousand three hundred feet per second, the velocity of the bullet, but one thousand one hundred feet per second, which is the velocity of sound. The bullet from a Lee-Metford rifle travels at two thousand feet per second, and consequently the wave front makes a sharper arrow-head (Fig. 2). On the other hand, when a bullet is moving at less than one thousand one hundred feet per second there can be no arrow-headed wave track, for the sound wave would run beyond the bullet. The figures show clearly that when the hum of a rifle bullet is heard overhead the bullet has already gone by, though everyone sympathises with the impulse to "duck." Meteors, which move much faster than bullets, are accompanied by a sound wave of extremely acute angle. The wave front does not reach the observer until the meteor has passed far beyond his station, or it may be not until some time after the meteor has burst. Therefore, as Prof. Boys has pointed out, the noise often heard after the bursting of a meteor may not even be due to the shock of its disruption, but must frequently, if not always, be caused by the wave track crossing the observer's position, a consideration which may avert erroneous calculations of the altitude and position of the bursting points of meteors.

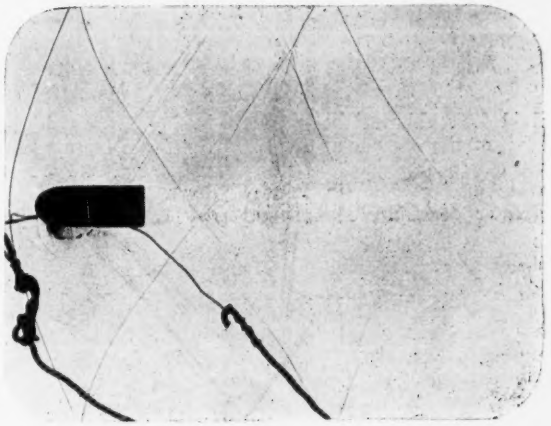
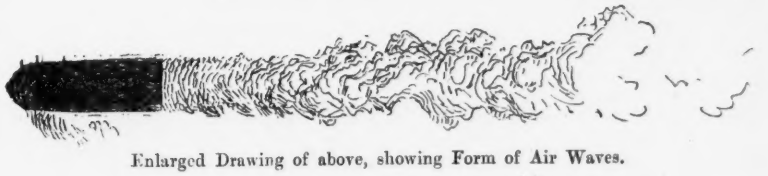


FIG. 1.—Photograph of Martini Bullet in Flight.
(*By permission of Messrs. Newton & Co.*)



Enlarged Drawing of above, showing Form of Air Waves.

A projectile being bodily immersed in air, the wave of compressed air travels out in all directions from the projectile, and in this the phenomenon differs from that of the surface waves given by a floating body. The wave front is really a cone-shaped shell. The photographs, however, do not show this, for it is only where the light meets the layer of compressed air at a grazing angle that the refraction is sufficient to give a dark line; through all other parts of the cone the light passes practically undiminished. The fact that the wave front has three dimensions instead of being a surface phenomenon, shows that the displacement of the air is not a hillock or billow, as in the case of water waves. The work both of a ship and a projectile is so far alike that they both drive the

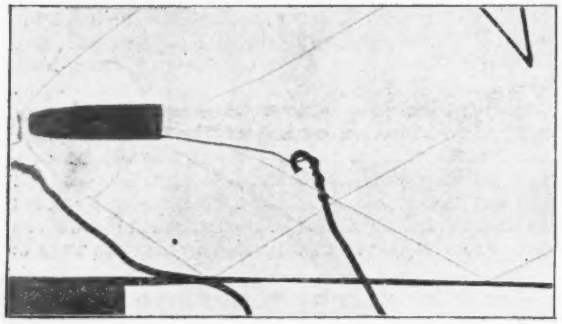
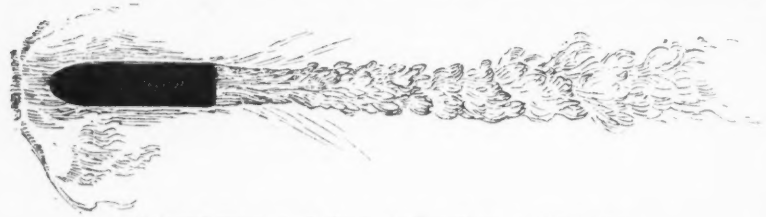


FIG. 2.—Photograph of Lee-Metford Bullet in Flight.

fluid forward from the stem, but in the case of a ship the level of the water is at the same time raised, whereas in the case of a projectile the displaced particles of air penetrate among those in front of them, thus producing a greater density. This action goes on continuously in



Enlarged Drawing of above, showing Form of Air Waves.

front of the bullet where the wave is created, and on either side where the wave is travelling freely the compressed air acts similarly, transmitting its energy to the neighbouring layer of air, which, being thus compressed, becomes in its turn the wave front. The particles of air in the first layer then recoil promptly to their original places, the layer returning at once to the ordinary pressure of the air. Thus behind the sound pulse there is no noisy turbulence of the air similar to the persistent heaving of the sea. The motion of the air particles is wholly forwards and back to rest along the same path, the whole of the energy of motion being transmitted during this single oscillation, as in a "long wave." Were it otherwise, the air would be filled always and everywhere with a jangle of sounds.

The velocity with which a free sound wave propagates itself through any gas depends upon the elasticity with which the gas recovers its state when pressure is released. This force of elastic recovery depends *directly* upon the pressure.* The velocity also depends *inversely* upon the density of the gas, which is itself proportional to the pressure, so that, taking both factors into account, the velocity of propagation of a sound does not depend upon the violence of the compression—that is to say, upon the loudness of the sound. Were it otherwise an orchestra could not keep time for an audience.

This law only holds, however, for reasonable pressures. With excessively violent compression the speed is somewhat greater. Thus, in Fig. 2, close to the V-shaped reflector on either side, the wave front is in advance of its proper position, where the darkness of shadow (at least in the original photograph) shows that the intensity of the sound is great. The V-shaped reflector was arranged so that the sound met it at a grazing incidence. In this case the wave is not reflected, as it is from the plate near the bottom of the figure, but, instead, it gathers force by what Scott Russell called "lateral accumulation." Something of the same kind happens with the "solitary" canal wave when it meets a wall at a grazing angle. The increased velocity is in this case connected with the increased height resulting from lateral accumulation, which causes the wave to travel faster by increasing the effective depth of the canal. The wave ultimately forms a breaker. Perhaps the extra swiftness of very loud sounds may be due to breaking, or rather spraying, jets of air shooting forward from the wave front and accelerating the compression of the next layer. Lateral accumulation is, Prof. Boys thinks, the secret of whispering galleries, the sound running round the wall without any true reflection. Perhaps it may also be a reason why sound often carries so wonderfully over water.

The movement required to make an audible wave must be sharp and quick, but may be very small. Lord Rayleigh has shown experimentally that a displacement of air particles of less than one ten-millionth of a centimètre in amount is distinctly audible. On the other hand, the motion of a large mass does not give rise to an audible wave if the motion be so slow that the air can escape compression by sliding round its sides and in behind.

Solid bodies, when struck, tremble with a rapid movement, and this is the usual source of sounds. A solid in regular vibration sends out a succession of pulses, each of which is an elastic air wave independent of those which precede and follow it. As, however, many bodies, especially those which are uniform in material and regular in shape, vibrate persistently at a constant rate, the sound pulses thus produced succeed one another in a perfectly regular manner—a definite, short, lapse of time and a definite distance separating each pulse from that which precedes it and from that which follows. Such a regular succession of pulses has a *note* depending upon the interval of time between them, or, which comes to the same thing, upon the distance from crest to crest. This distance is called the wave-

* Allowance must be made for the fact that in the sharp and sudden compression of the air which takes place when sound is made the air becomes heated. Conversely, sudden heating, as in the explosive combination of gases, develops pressure, which heats and assists in firing the next layer, detonation proceeding as a wave which is very much like a violent sound wave. It seems as if jets of heated gas are projected from the front of the "explosion wave," helping to fire the mixture in front. Such jets correspond to the spray shot forward from a breaking wave.—(*Vide* Dixon on "The Rate of Explosion in Gases": *Phil. Trans.*, 1893.)

length of a musical sound or note, but there is no such physical connection between the waves as there is in a group of ship waves or of wind-raised waves; they are independent of one another, like the successive ridges of water which roll in upon a flat shore after the bursting of the breakers. Each vibration of a solid consists of a forward and a backward swing. During the former the air is compressed; during the latter it is rarefied; each pulse of compressed air being followed by one of rarefied air. The whole air-space round the sounding body thus becomes a series of concentric shells of compressed and rarefied air. The compressed parts may be called crests, the rarefied parts troughs. The middle C string of a piano sends out waves of which the crests are separated by distances of about four and a-half feet.

The quality or timbre of a note depends upon the physical character of the individual air pulses, which in its turn depends upon the manner in which the vibrating body executes its swing-swang motion. Each vibration of a tuning-fork compresses the air gently at first, the pressure rising gradually to a maximum, and then decreasing as gradually. This gives a smooth soft sound. The vibration of a violin string, on the other hand, after compressing the air to a maximum, releases the pressure very suddenly; hence its sharper sound. The curves often used to represent sound waves are no more like them, in the ordinary sense of likeness, than an equation is like the curve it expresses; and the similarity of these curves to the forms of water waves sometimes misleads people into a mistaken notion of the kind of similarity between sound waves and water waves. A shaded band is the most natural mode of representation.

Although different sound waves travel at the same speed, yet, owing to the difference of interval between the pulses sent out by bodies not accurately tuned to the same note, reinforcement and enfeeblement can take place between sounds, much as in the case of water waves. "Beats" are thus similar to the occasional arrival of unusually large breakers.

We have considered the forms of wave front given by a projectile and by a vibrating body, each immersed in a deep ocean of air. A disturbance on a sufficient scale to affect the atmosphere through its whole height sends out a wave which has a very different form of wave front. Such were the explosions which accompanied the final paroxysms of the Krakatoa eruption. These sent out elastic waves which must have moved the air to the highest limits. Viewed as a whole, the atmosphere is a thin spherical shell or envelope surrounding the solid earth. The front of the great Krakatoa air wave was, therefore, a ring or annulus with a nearly vertical face equal in height to the height of the atmosphere. From Krakatoa the pulse radiated out to all points of the compass, the ring-shaped wave front attaining its greatest dimensions when the wave had gone halfway round the earth from its starting point. Then of necessity a contraction of the ring began, and this continued until, at the antipodes of Krakatoa, the disturbance was approximately focussed round a vertical line. From this focus of concentrated energy the wave front again expanded to the full circuit of the earth, and then, contracting, focussed once more around Krakatoa. Thence once more the wave spread out, and thus continued, with diminishing intensity at each journey, for several complete circuits of the globe. The record of its marvellous journey was registered by barometers in all parts of the world, the mercury column responding to the variation of pressure as the air pulse passed each recording station. This was a sound wave, as its rate of travel showed, though it affected the barometer far beyond the range at which the noise of the eruption was recognized.

The audibility of a sound depends upon the amount of compression of the air at the point where the wave encounters the auditor. In the above case the effect upon the barometer was greater than that of sounds more locally intense, owing presumably to a nearly simultaneous increase in density in the whole atmospheric column above the barometric station.

The effect of wind upon the velocity of sound is easily understood; the disturbance advances more slowly, relatively, to an auditor on the earth's surface, when the air is bodily moving in the opposite direction to the wave of sound. This does not explain why sound becomes so much feebler when travelling against wind, for the existence of a current ought not to affect the amount of condensation and rarefaction. Experiments made by Prof. Osborne Reynolds show that sound going against wind is thrown upwards, and passes over the head of the listener. By ascending to a height from the ground, the sound can be caught again. This is probably due to the circumstance that the wind is stronger above than below, where it is retarded by the ground; the front of a sound wave travelling against the wind being consequently tilted upwards. Down wind the tilt would be downwards, and the sound should therefore be kept close to the ground.

The sound wave travels quicker in hot air than in cold, the density being less for the same pressure; consequently on passing obliquely from a stratum of hot air into a stratum of cold air, the front of the sound wave swings round, as the rollers from the sea wheel round upon the end which first reaches shallow water. The continual refractions and reflections which sound undergoes when the air is irregularly heated interfere greatly with the carrying power of sound. Thus a hot bright day, even when there is no wind, is often bad for sound; whilst a fog, which screens off the rays of the sun, often makes the air more transparent to sound, for the little fog particles are too small to interfere much with sound waves. Only obstacles of large size cast a sound shadow, the wave-length of ordinary sounds being considerable; a man's head, for instance, scarcely screens off sound at all. Were it otherwise, the ears would have to work independently. Similarly, to concentrate sound to a focus would need a very large lens, so that the ear has no focussing arrangement corresponding to the crystalline lens of the eye, and our perception of the direction of sound waves remains less perfect than of light waves.

## LINOLEUM.

By Dr. GEORGE MCGOWAN.

MANY a one has doubtless put to him- or herself the question—What is linoleum, and how is it made? As this material is now so widely and universally used for household purposes, a few notes from an exhaustive article upon its history and manufacture, contributed by Mr. Walter F. Reid to the February Number of the *Journal of the Society of Chemical Industry*, may not be without interest to many readers of KNOWLEDGE.

Although linoleum itself is quite a modern product (the first factory for it was started only thirty years ago), it has had numerous precursors, the earliest of which was waxed cloth or canvas. A varnish called "linoleon," containing linseed oil, was used in the eighth century; and in 1239—*i.e.*, during the reign of Henry III.—we find oil being employed for painting in this country. In 1636 a patent was granted for "painting with oyle cullors upon wollen cloath, kerseys, and stuffes, being pper" (?) "for hanging, and alsoe with

the said cullors upon silk for windowes." Numerous mixtures of oils with resins were used until 1751, at which date mention is first made of india-rubber or gum lastic as an ingredient in the coating material. In 1844 Mr. E. Galloway proposed the addition of powdered cork to plastic india-rubber, in order to give a "certain elasticity" to the combination, and cloth coated upon one side with this mixture was brought into the market as a substitute for floorcloth, under the name of "kamptulicon." This latter was the immediate forerunner of our present linoleum, for which we are indebted to Mr. F. Walton. And now, at the present moment, there are twenty-five factories in operation, the greater number of them being in this country, at which 12,000,000 yards of linoleum are annually produced.

The two main ingredients in the manufacture of linoleum are cork and linseed oil, to which are added smaller quantities of kauri gum, resin, and pigments of various kinds. In the manufacture of bottle corks about one-half of the cork is wasted, and this waste is the chief source of the cork for linoleum. Mr. Reid, however, adds that in the cork forests of Algeria, etc., there is plenty of material available which, while not suitable for bottle corks, would answer admirably for linoleum. The cork waste, after being freed from dust and other admixed substances by means of a sieve with a rapid reciprocating motion, is crushed. This sounds very simple, but, as a matter of fact, the machinery required for the actual operation has to be of a very special character, both on account of the elasticity of cork and also because of the almost incredible rapidity with which it blunts the hardest steel knife-edge. The breaker reduces the cork to pieces of about the size of a pea, in which state it is passed on to the grinding mill, the latter being like an ordinary flour mill, but with stones of lava, sandstone, or some other rough material. Cork dust being excessively light, it quickly disseminates itself through the air of the mill; hence the utmost precautions have to be taken to ensure the protection of all artificial lights, and thus to prevent the explosive mixture of air and cork dust being set on fire. Even with every precaution, small explosions are sometimes caused by sparks from the machinery. The author says, in fact, that "speaking after considerable experience of both materials, I would rather handle dynamite in bulk than cork in a loose state." The dust has not yet been bleached successfully, *i.e.*, the colouring matter adheres to it with such tenacity that it can only be got rid of at the cost of lessening the strength and elasticity of the cork itself. Further, although many experiments have been made with the view of replacing cork by other substances—sawdust, spent tan, peat, etc.—the resulting product possesses less elasticity than when cork is used, and so wears out more rapidly.

The next stage in the manufacture is the preparation of what is technically known as "cement," the chief ingredient of which is oxidized linseed oil. As everyone knows, oils are divisible into two classes, drying and non-drying oils, the "drying" being brought about in the case of the first-named by the absorption of oxygen from the air, and the consequent transformation of the oil into a solid resinous mass. For linoleum manufacture the linseed oil used must be of good quality, and great care must be taken in its treatment. The oil is first boiled, much as in the manufacture of paints and varnishes. It has been found that the process of drying is much facilitated by the addition of a small quantity of the oxides of lead. The boiled oil, after being allowed to deposit any sediment in a settling tank, is pumped to the top of a high building, and from thence allowed to flow over a number of pieces of light cotton fabric known as "scrim," which hang vertically from iron bars. The air in the building being heated to a temperature of about 100° Fahrenheit, the layer of oil which adheres to the surface of the scrim becomes rapidly oxidized, or, in other words, it solidifies in the course of twenty-four hours. This operation is repeated daily for six to eight weeks, until a sufficient number of solidified layers of oil are deposited on the cloth, the mass of oxidized oil having now a thickness of half an inch, and being termed a "skin." The skins are then cut down and ground between rollers. This plan of drying the oil is a slow one, but more rapid methods have apparently not been found to answer very well as yet, because there is a danger of pushing the oxidation too far, in which case the dried oil again changes into a liquid.

To prepare the linoleum "cement" itself, the ground oil is mixed with resin and kauri gum in different proportions until the whole mass is homogeneous. And here again fire has to be guarded against, as the cement has a great tendency to heat and even to inflame if left in bulk exposed to the air. The cement and cork dust are now intimately mixed together by machinery in a series of operations, various colouring matters being added at the same time, according to the colour required for the finished linoleum. This linoleum mixture is then rolled on to jute canvas, to which it is made to adhere thoroughly. It should be added that, instead of jute, wire gauze imbedded in india-rubber is now being much used, especially for linoleum intended for staircases.

Linoleum, as prepared above, is of the same colour throughout, and when an ornamented surface is required the designs are printed upon it in oil paint. This, of course, merely gives a surface colouring, which is liable to wear out, and hence various plans have been and are being tried with more or less success, whose object is to produce a mosaic linoleum coloured throughout its entire thickness. But although such linoleums with inlaid colour patterns have some advantages over the older kind, they have also—up to the present time of writing—certain disadvantages.

Plain linoleum is usually made in two colours, brown and red, of which the brown is the more elastic. The fact that wet linoleum is stained when any article of iron is placed upon it must often have been noticed, this being due to the tannin contained in the cork. In course of time linoleum loses its elasticity and becomes brittle, this being caused in the first instance by a change in the cement induced by further oxidation, the cork remaining unaltered. With regard to this the author of the paper remarks that a more stable cement will probably be worked out in time—possibly one derived from mineral oils, which have little or no tendency to undergo oxidation in the air. The linoleum industry, already a large one, will doubtless continue to grow, and the manufactured product itself to improve. Space will not permit of our entering into further details regarding it here, and any reader who wishes to know more about the subject is therefore referred to Mr. Reid's able and interesting paper.

## THE SOOTY OR BROWN ALBATROSS.

THE accompanying reproduction is from a photograph very kindly supplied by the Hon. Walter Rothschild. It was taken, as was the photograph of the white-breasted albatrosses reproduced in KNOWLEDGE for April, 1895, by Mr. Rothschild's collector some years ago, in Laysan Island, on a sand-bank in the Pacific off the Sandwich Islands.

The sooty or brown albatross, sometimes called the

Kindly supplied by the Hon. WALTER ROTHSCHILD, and reproduced by his permission.

**PHOTOGRAPH OF THE COLONY OF SOOTY ALBATROSSES ON THE SOUTH SIDE OF LAYSAN ISLAND, A SANDBANK NEAR THE SANDWICH ISLANDS.**

Kindly supplied by the Hon. WALTER ROTHSCHILD, and reproduced by his permission.

brown gooney, and scientifically known as *Diomedea chinensis*, is one of the commonest species of the genus. Gould says of the birds of this species, in his "Birds of Australia," that their actions and mode of flight differ considerably from those of all other species of albatrosses, their aërial evolutions being far more easy, their flight much higher, and their stoops more rapid. The cuneated form of the tail, which is peculiar to the species, together with the slight and small legs and more delicate structure, clearly indicate the most aërial species of its genus.

On French Frigate Island, Laysan, and all other islands visited by Palmer (Mr. Rothschild's collector), the dark albatross was fairly numerous. On Laysan Island the breeding-place was to the south side of the island, where the birds sat on the beach with their young, as is shown in the photograph.

The young feed by putting their beaks crosswise into the old bird's mouth, and thus they catch the cast-up fish.

Herr von Kittlitz, who visited these islands in 1828, remarks that the sooty albatrosses are extremely foolish and fearless. They can be caught with the hands, as they must run a good distance before being able to get up on the wing. If two birds meet, they bow to each other, uttering a low cackling. When Herr Izenbeck, a friend of Herr von Kittlitz, met one he used to bow to it, and the albatross was polite enough to answer, bowing and cackling. This could easily be regarded as a fairy tale; but considering that these birds, which did not even fly away when approached, had no reason to change their customs, it seems quite natural.

The brown gooney in colouring is sooty brown above, with the forehead a dirty white; underneath the colours are much paler and more grey. The quills and tail-feathers are blackish brown, and the bill dark brown with a blackish tip. The total length of the bird is thirty-three inches, the wing being nineteen inches in length.

The French Frigate Islands, Laysan, and other islands in this group, are simply low sandbanks with little or no vegetation on them, but they are covered with birds. One would expect that these immense colonies would not be altogether peaceable, and that such is the case may be gathered from the following anecdote told by Palmer of the frigate-bird, found there in large numbers. He says: "Scarcely had I pushed one off, when another frigate-bird would rush up, seize the young one, fly off, and eat it. Sometimes the parent bird would give chase, but it always ended in one or the other eating the young bird. I could scarcely believe my own eyes, so I tried several; but they would even take young birds out of the nest which were almost fully feathered."

## THE CAUSES OF COLOUR.

By J. J. STEWART, B.A.Cantab., B.Sc.Lond.

THE beauty of the objects of nature around us depends so much on the varieties of colour which they exhibit that it becomes an interesting question, what is the cause of these differences? We have only to think of the blue sky, the green foliage, and the various splendours of flowers and fruits to realize to how great a degree the pleasure we experience in viewing a country scene is due to the many-hued surfaces of natural objects. The pleasurable feelings aroused by the sight of the deep blue of the sea contrasting with the bright red colour of the sandstone cliffs, or the effect of the sunshine when it lights up the splendid purple of the heather on the slopes of the hills, can be forgotten by none who have experienced them; and the striking effect of Eastern scenes is owing largely to the brilliance of the tints which meet the eye. It is needless to enlarge on the part played by colour in this world of ours; the difference between a world of colour and one in which surrounding objects were only distinguished by different shades of grey can be realized by all.

When we come to enquire how the red colour of a rose is produced, and why it differs in appearance from a blue flower, we must consider what happens to the light which falls upon the petals of the rose. We see the flower because the light from the sun is reflected from it, but something has happened to the light before it reaches our eyes; the light we receive differs from that which fell upon the flower. The rays from the sun penetrate to a certain extent into the substance of the flower, and most of them are reflected from particles beneath the surface. Now the cells making up the petals of a rose contain a fluid which has the power of absorbing certain of the rays of light, and the light entering the eye after penetrating a short distance below the surface of the petals and coming back has passed through this fluid, and in its course some of the rays of the sunlight have been abstracted from it. Thus the light reaching us is lacking in certain of the constituents of white light—that is, it is coloured. White light may be considered as made up of the three fundamental colours, red, green, and violet, blended together. The light which has passed through a certain extent of the substance of the rose petals has been deprived of its green and violet portions, and thus the red rays alone reach our eyes. All substances which possess colour exercise this power of sifting the rays of light. Light falling on the leaves of the rose-bush passes through their superficial layers and is reflected from below the surface; thus it has to traverse certain particles which take from it the red and violet rays and allow the green to pass. The green rays which escape absorption are the only ones which reach our eyes, and we therefore call the leaves green.

When white light passes through a prism it is found that in the band of colour or spectrum produced, the blue and violet rays are the most bent out of their original course: they are the most refrangible. The red rays are the least bent. It is found also that the vibrations of the ether filling space which produce waves of light are quickest in violet light and slowest in red light. Some substances absorb the quick vibrations more readily and thus appear reddish in colour. Others absorb the slower vibrations, allowing the others to pass through, and therefore have a green or blue colour.

When a substance is heated its particles are thrown into a state of rapid motion, and soon set up a motion in the ether which, when the vibrations are of a certain rapidity, produces light. If a ball of iron is heated it first of all gives out radiation consisting of dark rays which have the effect of producing heat. As its particles become hotter and hotter, and thus vibrate more rapidly, the radiation begins to affect our eyes and the ball glows with a dull red heat. As vibrations of greater and greater rapidity take place owing to the further heating, the ball appears bright yellow, and finally white, when vibrations of all the different rapidities which affect our eyes are given out. In this case it is the motion of the particles or molecules of the heated body which is imparted to the ether, and so produces the effect we call light. Now those molecules which are able to execute certain vibrations and give them to the ether, absorb these same vibrations from the ether—that is, absorb certain rays of light. This effect is best seen in the case of gases, and the phenomenon is analogous to that which occurs with sound. A tuning-

XUM

fork or stretched wire which can give a certain note when it is struck, is able to take up and absorb the note from the vibrating air around it when that note is sounded in its neighbourhood.

It may be noticed that the light from the electric arc when seen near at hand has a distinctly bluish colour; but this same light when viewed from a distance appears yellowish, as certain of its rays have been absorbed by the water vapour in the air on its passage to the eye. For a similar reason the sun is now considered to be a blue star; his light, which would appear intensely white, and rich in blue rays especially, if it could be seen from beyond our atmosphere, appears yellowish after it has passed through that atmosphere and has lost some of its most refrangible constituent rays.

The effect of absorption in producing colour is seen from the fact that powdered bodies generally appear white. This is accounted for when we consider that a powder consists of particles arranged at all angles, so that the light falling upon it meets various surfaces and is mostly reflected before it has passed below the surface. Thus the white light reaching it, is not deprived of some of its constituents by selective absorption, as it would be if it penetrated the substance and was then reflected. In this way powdered red glass appears white. For a similar reason the froth of coloured liquids, such as brown ale, appears pure white. The light is reflected from the surface of numerous small bubbles, and does not pass much through the liquid itself. Thus also a cloud is very opaque to light, the light falling on it being reflected at the surface of the numerous globules of water. To this is due the brilliantly white appearance of large fleecy clouds in bright sunshine.

Some substances absorb equally all the rays of light. Such substances, of which soot is an example, appear black. The reason why a flower like a white lily appears white is that the fluid contained in its cells does not absorb one sort of rays more than another, but allows all to pass with comparative freedom. White light then reflected from its surface, or from a little below, is not deprived of any of its constituents, but remains white.

The effect of reflection from internal surfaces accompanied by absorption in producing colour, can be seen by pouring a coloured liquid, carefully freed from floating particles, into a white porcelain basin. Light is reflected from the sides of the basin, passes through the liquid, and its colour is seen. If now the sides of the basin be covered with some black substance, no light will be reflected from them and the liquid will appear black; no light comes to the eye from the interior, and the surface of the liquid reflects all the rays equally. If next we place in the black-looking liquid a white powder like chalk, its colour is at once restored, light being now reflected from the interior at the surfaces of the chalk particles.

From the above considerations we can understand to what causes the colour produced on mixing pigments is due. A mixture of blue and yellow paints has a green colour because that is the only colour transmitted by both pigments. The blue paint absorbs the red, orange, and yellow rays, allowing the others to pass through it; the yellow paint absorbs the blue, indigo, and violet. Thus green rays alone are permitted to pass through both, and the result is that the mixture appears of that colour.

Some substances appear of one colour when viewed by reflected light, and another when seen by transmitted light. Thus the light reflected by gold is yellow; but a leaf of gold made so thin that light can pass through it appears of a green colour. This appearance of different colours on reflection and transmission is also seen with many of the aniline dyes. The colour of the light due to reflection is then made up of those rays which are not admitted at all, but sent back at the surface, together with that light which has been reflected from a certain depth below the surface, and has thus lost some of its constituent rays by internal absorption. The light to which the colour is due when the substance is viewed by light which has passed through it, is that which has been deprived of some rays by reflection at the first surface, and again of others by absorption in passing through. Hence the difference of colour when viewed in the two different ways.

Variations in colour perception no doubt depend on varying sensations in our own eyes as well as on changes in the light itself. Some curious experiments have been made with a view to testing our different sensations as to colour. It has often been noticed that a bright scarlet uniform will appear perfectly white in a good photographic dark room with ruby glass windows. With regard to such effects, Herr H. W. Vogel described recently in Berlin some experiments he had made. He used oil lamps and fitted on to them pure red, green, and blue colour screens. It was found that when the white light was entirely shut out, no sense of colour was perceptible to the observers, and objects in the room appeared of various shades of black and white. He found that when a set of colours was lit up by red light, the red pigments appeared white or grey, and this changed at once into yellow, not into red, when blue was added to the light under which they were viewed. Thus a colour was perceived which did not exist in either of the sources of light used. The colour sensation produced by a source of light also depends partly on the intensity of the illumination. From these and similar experiments, Herr Vogel comes to the conclusion that our opinion as to the colour of a pigment depends upon our perception of the absence of certain constituents from the light reflected from it. Thus a surface which has a red colour is only perceived as red by us when light of other colours shines upon it, and we observe its incapacity for reflecting these colours.

When a solution of quinine is viewed in sunlight, a remarkable blue shimmer is noticed extending for a short distance beyond the surface at which the light enters. A similar effect is noticed with many other substances, the colour being different in different cases. The phenomenon is known as fluorescence, as it is well observed in the mineral fluor-spar, and is due to the fact that light is absorbed by the substance and is again given out as light of a different colour. For instance, rays of high refrangibility towards the blue end of the spectrum may be taken in and given out as yellow rays of lower refrangibility. In the case of quinine, invisible rays beyond the violet are absorbed and blue or violet rays are emitted by the solution. In all cases of fluorescence a degradation of the rays takes place; those given out are of lower refrangibility than those which disappear on absorption. By painting a screen with a solution of sulphate of quinine, the spectrum beyond the violet can be made visible, as those vibrations which are too rapid to affect our eyes are changed into others of lower refrangibility, which can be perceived when they fall on the retina. The curious blue colour of the solution of quinine extends only a short distance into the liquid, because those rays which are capable of producing it are soon absorbed, and the light which passes onward through the fluid is destitute of such rays. The colour produced in cases of fluorescence has a different origin from that of the ordinary surface colour of substances, for the rays absorbed do not disappear as light, but their place is taken by other rays of a different sort.

The nature of the vibrations which constitute light still

remains mysterious, but great advances have been made in recent years in our acquaintance with these and allied phenomena, and we may hope for still greater accessions to our knowledge in the not distant future.

## MICROSCOPY.

By A. B. STEELE.

IT is stated on some authority that magnifying lenses were not in use till about the end of the sixteenth century. It was known long before then, however, that letters were enlarged when seen through a globe filled with water, but it was thought that magnification depended upon the nature of the water or of transparent bodies, and not upon the lenticular form of the glass. From the gradual deepening of curves, no doubt, the idea originated of producing lenses of shorter and shorter focus, until the combination of a convex lens as an objective with a concave lens as an eyepiece, distanced apart by the hands, led to the discovery of the telescope. Its conversion into a microscope would immediately follow, for, as Herschel says, a telescope used for viewing very near objects becomes a microscope.

The first microscope would most likely be in the shape of a hand lens, and this would soon be improved upon by mounting the lens at one end of a tube with the object held at the focus or attached to a piece of glass. For higher powers some system of focussing would be applied, either by sliding the object cover or the lens, and for still higher powers globules of blown glass would be used. It is said that Huyghens brought microscopes from Holland of minute spheres of glass about the size of a grain of sand, and one of the earliest experts in microscopical observations is said to have constructed an instrument of blown glass and used it in the discovery of minute forms of life. The honour of having produced the first microscope consisting of a combination of lenses is generally ascribed to a spectacle maker named Jansen, in the small town of Middelburg, in Holland. The date can only be approximately given as shortly before or after the beginning of the seventeenth century. One of Jansen's microscopes was found at Middelburg in 1850, and was exhibited at the Loan Collection in London in 1876. It resembles one of the present-day compound microscopes without the field lens. At the time of its manufacture clear glass was scarcely to be had in Holland, and microscopes were constructed with lenses of rock crystal and designed to view opaque objects by reflected light.

In 1637 Descartes published a description of a simple microscope which was a decided improvement upon the form commonly used before his time. It consisted of a simple lens mounted in a central aperture in a polished concave metal reflector, and was practically the same as the lens constructed a century later. He also designed a machine for grinding and polishing lenses, nearly a quarter of a century before practical men had their attention drawn to this important subject. But about this time the man whose fame as a microscopist is best known, and who gave the first real impetus to microscopy, was Hooke. He was the first to employ diffused light instead of direct sunlight. He introduced the field lens, and invented the ball and socket movement in the construction of the microscope. He was also the first to discover that a drop of water placed on the front lens of the objective would allow more light to pass than a dry lens could in the proportion of unity to the refractive index of water. Such lenses were subsequently known as immersion lenses. So distinguished a person was Hooke that Herschel speaks of him "as the great contemporary and almost the rival of Newton." It was not till nearly fifty years after his time that microscopes were provided with mirrors. The early system of focussing seems to have been effected by a 'screw-barrel" arrangement acting on the object, which was clipped between two plates and depressed from the objective by a spiral spring; and "screw-barrel microscopes"—so named from the objective being mounted in a little barrel—became common in the eighteenth century. Many improvements in the screw-barrel system of focussing were introduced, but all were more or less defective, until a plan was discovered by which the image would remain steadily in the field, and allow the object to be viewed during the actual process of focussing.

The invention of means to determine the exact magnifying power of any objective is due to Benjamin Martin, who applied a screw micrometer to the eyepiece with fifty threads to the inch, so that the precise number of diameters could be stated. A ruler, divided into tenths of an inch, was placed under the microscope so as to have a tenth in full view on the image; then by measuring it with the microscope, and counting how many turns were made in so doing, the number of turns divided by five showed how much larger the image was than the object. Martin made a large compound microscope for His Majesty George III., which is now in the possession of the Royal Microscopical Society. The instrument stood on the floor, and was so large that the King could conveniently use the eyepiece while sitting in his arm-chair. The compound microscope of to-day, known as the "Continental model," by which most of the scientific work of our time has been performed, was evolved out of Martin's reflecting microscope. In designing and executing microscopes Martin excelled all others of his day. But his fame rests chiefly on his being the first to construct an achromatic objective.

The possibility of applying achromatism to the microscope attracted the attention of men like Wollaston, Herschel, and Brewster, but, notwithstanding the researches of these, its adoption made slow progress. In fact, there is very little difference in the definition of the image between a microscope made last century and one made during the first quarter of this. It was achromatism that gave the stimulus to the discovery of a more precise means of focussing, and since its application in 1824 by the French optician, Chevalier, the development of the microscope has made greater progress than during the whole former period of its existence. The neglect given to fine adjustment can only be accounted for by there being little or no original investigation done with the microscope, and consequently there was no impetus given to its development. The best designs of fine adjustment were first devised by Englishmen. To Powell we are indebted for a system of focussing applied to the nosepiece. In Andrew Ross' instruments the fine adjustment tube was raised and depressed by means of a screw acting upon the end of a lever of the second order, while in those of Powell and Lealand the screw acted upon a lever of the first order. The rival to these was the "Jackson system," the fine adjustment of which was deficient in delicacy and precision, chiefly owing to the extreme shortness of the acting lever. Lister's discovery of aplanatic foci led to still greater improvements in objectives, for his investigations were taken advantage of by three of the then leading firms of opticians in London, and very fine objectives were produced after long and persistent experiment.

The first really practical immersion lenses were made by Prof. Amici, of Modena, and were improved upon by Hartnack and others, who succeeded in producing such excellent objectives as to make it possible to resolve the

XUM

most difficult tests known to microscopists. Water immersion lenses were constructed by Englishmen about 1860, who made both new lenses and also new front combinations to screw on to old glasses. About twenty years ago a farther great advance was made by Mr. J. W. Stephenson, of the Bank of England, who induced the firm of Zeiss, of Jena, to construct lenses in which a drop of cedarwood oil was substituted for water. These were termed homogeneous immersion lenses, because the oil being of the same refractive index as the glass of which the objective was made, the light from the object passes into the optical system without refraction. But for greater improvements still we are indebted to the optical knowledge of Prof. Abbé, of Jena University, in combination with the mechanical skill of the late Carl Zeiss. In every achromatic object-glass it is impossible to unite more than two rays of the dispersed light in the spectrum, viz., red and green, the others being left out and forming what is called the secondary spectrum. It occurred to the Professor to construct an objective with the mineral fluorite —which has a very low refractive index—as a component, and so to obtain a greater command over the removal of the chromatic dispersion. He thus devised what are now known as apochromatic objectives, which are slightly overcorrected for colour, while the eyepieces used with them are under-corrected, the result being that three rays of the spectrum are united and an almost colourless image is produced. The magnification by means of these eyepieces may be carried to a large extent, eyepieces having a magnification of twenty-five times being used with these objectives without any apparent degradation as regards colour, especially with the lower powers. This discovery has been followed by every optician of note, both here and on the Continent, and it may be truly said that no scientific work of any importance with the microscope can be done without an apochromatic objective. The microscope has by this means been firmly established on a footing which the telescope can never, we fear, hope to possess. It "holds the head" in optics, as our French neighbours say. It is much to be regretted, however, that we are so very dependent upon foreign workmanship for the optical tools with which important scientific work is done. Our British manufacturers are no longer leading but following, for most of the firms are making microscopes upon what is called the "Continental model," the instruments with which nearly all real scientific work is done at the present day.

## A QUARTER OF A CENTURY'S WORK ON RESPIRATION.

By C. F. TOWNSEND, F.C.S.

AMONG the achievements of this century, the advance that has been made in our knowledge of physiology will not be the least. The brain and the various glands, however, have absorbed the lion's share of attention, and, until the work of Drs. Haldane and Lorraine Smith awoke renewed interest in the subject, the study of the lungs had been largely neglected. Of the few who have devoted themselves to this branch of research, Dr. W. Marcet, F.R.S., has been the most constant, and has given a large part of his life to the solution of the problems connected with respiration. His investigations have not been confined to the laboratory, but have been conducted frequently in the open air at varying elevations, extending from sea-level to the summit of the Breithorn. Most of the results are scattered through the *Transactions and Proceedings of the Royal Society;* but recently Dr. Marcet, as Croonian Lecturer to the Royal College of Physicians, had an opportunity of summing up the whole of his work.

The early experiments during three summers in Switzerland gave decidedly interesting results. The following stations were chosen :—

1. Yooire on the Lake of Geneva ... 1,230 feet.
2. The Hospice of the Great St. Bernard 8,115 ,,
3. The Riffel Hotel, Zermatt ... ... 8,428 ,,
4. The Hut in the St. Theodule Pass ... 10,899 ,,
5. The Summit of the Breithorn ... 13,685 ,,

The person under experiment breathed through a face-piece made to cover both mouth and nose, and fitted with ebonite valves, so that the air coming from the lungs (expired air) should pass without loss to the receiver—a large india-rubber bag, communicating with the face-piece by a flexible tube. Breathing was commenced at a given signal and continued until a definite volume of expired air had entered the bag. The time required for the lungs to expire this volume of air was determined accurately by means of a stop-watch. The results showed an increase of carbonic acid given off, equivalent to increased combustion at high altitudes in the Alps. The actual weight of air breathed in a given time was less, however, at high altitudes than at the seaside. It follows that breathing is easier in the Alps than in the plains.

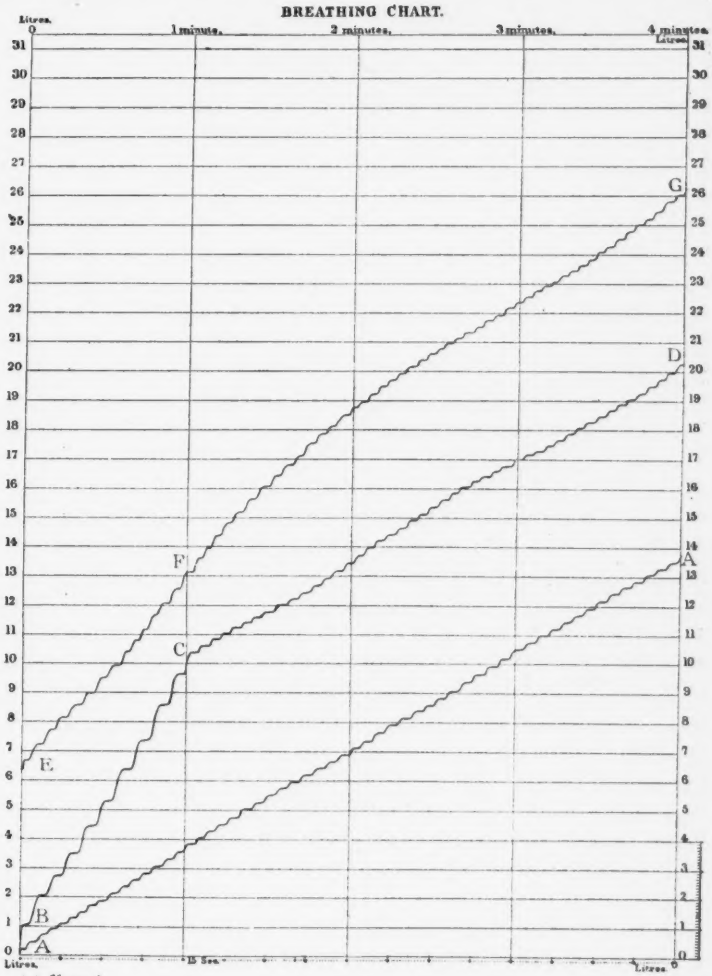
In order to ascertain whether the increase in the carbonic acid given off from the lungs, and consequent greater chemical action, was due to cold or to altitude, Dr. Marcet, in 1878, determined to proceed to Teneriffe, with the necessary apparatus for continuiug the research. The baggage included a shed of wood and canvas made to take to pieces, a chemical balance, a number of sealed bottles full of standard baryta solution for the determination of carbonic acid, tubes filled with calcium chloride for the determination of the moisture in the air exhaled from the lungs, provisions, and everything necessary for camping out on the Peak for three weeks. An Alpine guide from Chamounix, who had assisted the investigator in his previous expeditions, again accompanied Dr. Marcet. The great advantages of Teneriffe for this work were, first, its accessibility; secondly, its dry climate and its Peak, which rises sheer out of the sea to a height of over twelve thousand feet; but mainly the fact that stations could be selected at various heights on the Peak, varying but little in their respective temperatures.

In his book on "Southern and Swiss Health Resorts" Dr. Marcet gives a very interesting account of his expedition up the Peak. The first station was at the foot of Mount Guajara (seven thousand and ninety feet), and the camp was made on a patch of white baked clay in the old crater, which is now mostly a chaotic field of lava. The landscape is the most desolate and dreary that could be imagined, nothing but lava and volcanic rocks with an occasional patch of sand or clay baked by the sun, and a few straggling bushes of *Rhetama*—a kind of broom. The heat everywhere on the Peak seems to be very great whilst the sun is shining. Mr. Piazzi Smith, who was engaged in astronomical work on the Peak, found the temperature in the sun on the summit of Mount Guajara to be 212·4° Fah. It must have been but slightly less than this at Dr. Marcet's camp in July and August, although the cold was great at night. The radiation was intense, water left out in the open all night becoming a solid block of ice by the morning. The dryness of the atmosphere on the Peak was quite as remarkable as the heat. The skin became dry and scaly, so that it was almost painful to touch anything. Fresh meat brought up from Puerto Orotava kept good for any

length of time. Deal boxes split with the heat and dryness, as did the boots of the two members of the expedition, the soles coming away from the uppers, so that the party returned to the seaside in a somewhat dilapidated condition. From the highest station at Alta Vista (ten thousand seven hundred feet) two expeditions were made to the cone and summit itself, but the sulphurous vapours given off prevented any determination of carbonic acid being made on the summit.

The results of the experiments at Teneriffe showed, as had been anticipated, that there was no increase in the carbonic acid given off from the lungs between the seaside and the summit of the Peak; so that the increase found in Switzerland on the Col St. Theodule, the Breithorn, etc., must have been due to cold and not to altitude. In addition it was noticed, as had been the case in the Alps, that the actual volume of air breathed, reduced to normal temperature and pressure, was less than at the seaside.

Experiments were made on the amount of water exhaled from the lungs at the seaside and at the three stations on the Peak. The results showed most distinctly that the less the atmospheric pressure the greater the amount of water given off. This might have been expected, as a decrease in pressure is known to facilitate evaporation. In the winter of 1888-9, Dr. Marcet continued his inquiry into the subject of respiration. Instead of collecting the air expired from the lungs in bags, as had been done in the mountains, bell-jars were used in this latter work, which was carried out in the Physiological Laboratory at University College, London. These bell-jars held forty litres, and were so beautifully balanced that it was impossible for the person under experiment to tell whether he was breathing into them or into the open air. With the use of these bell-jars Dr. Marcet undertook an inquiry into the subject of re-breathed air. One of the bell-jars was filled with thirty-five litres of air, and the person under experiment breathed both into and out of this vessel for five minutes. At the end of this period, by merely altering the connections he was enabled to breathe with fresh air. The air coming from his lungs was conveyed to a second bell-jar, previously emptied. The conclusions derived from this work are interesting. A large proportion of the carbonic acid produced remains stored up in the blood, so that when fresh air is taken into the lungs large volumes of air are breathed, because of the desire to get rid of the excess of carbonic acid. All effects of re-breathing pass away in about six minutes when fresh air is turned on.




A A Normal
B C Forced, C D After Stage
E F Stepping 66 times per minute, F G After Stage

Regnault and Reiset were the first to observe that all the oxygen absorbed in the lungs was not returned as carbonic acid, a fact that has been confirmed by all later observers. Dr. Marcet found that this "occluded oxygen" was greatest in the hour that follows a meal, falling off, apparently, after that period; but the changes in this absorption of oxygen are so great that it is difficult to follow them at all closely. This oxygen is used obviously in tissue changes apart from mere combustion. We do not know by what process carbonic acid is generated in the body, but, according to Hermann, there is no single instance of direct oxidation in the chemical phenomena of life.

After completing this chemical work by the aid of an ingenious burette he had constructed for the purpose, Dr. Marcet undertook an investigation into the different forms of human respiration. Beginning with normal breathing in a state of repose, experiments were made on forced or laboured breathing, respiration under exercise, and respiration as controlled by the mental exercise of the will. In order to obtain records of these different conditions of breathing, an apparatus was employed to trace the actual movements of the lungs. For this purpose a glass pen, charged with ink, was fixed to the end of a rod attached to the bell-jar. The point of the pen pressed against a ruled chart stretched on a drum, made to revolve horizontally at a given rate by clockwork. The horizontal lines on the charts showed the number of litres of air expired, and the vertical lines the time in minutes. When breathing commenced the

clockwork was started ; the combined movements of the drum and the rising bell-jar giving a diagonal tracing or curve on the paper, showing exactly the rate at which the air was expelled from the lungs. The kindness of Dr. Marcet enables us to reproduce one of the charts, and a reference to it will enable the reader to understand the nature of the experiment better than any amount of explanation. The bottom curve A A shows normal breathing with the body in repose ; the next curve shows the working of the lungs under forced breathing—*i.e.*, when taking series of deep breaths intentionally—and the after-effect when the person returns to natural breathing ; the top curve shows the effect of exercise on the breathing. In the bottom tracing it will be noticed that the curve is practically a straight line, showing that about three and a half litres per minute were taken into the lungs regularly. In the middle curve two and a half times as much air was taken into the lungs as in natural breathing ; after this follows a short "pause," which is more marked in some of the other charts, then an increase above the normal, followed by a return to natural breathing. Sneezing, sighing, and yawning may all be considered as different forms of forced breathing.

The experiments on breathing whilst under exercise were carried out by "marking time" in military fashion—raising the feet a given distance off the ground, keeping time to a metronome, so that the work done could be measured approximately. The tracings obtained whilst breathing under exercise differ considerably from those illustrating forced respiration, especially on the return to natural breathing. During exercise the respirations, though deeper than the normal, are less deep than in forced breathing, and immediately on sitting down the line continues its upward tendency, showing no pause as in forced breathing ; then returning parallel to the normal. In talking, singing, reading, and coughing, the respiration assumes the form of breathing under exercise ; but in talking and reading, where the strain on the lungs is very feeble, the tracing returns parallel to the normal almost immediately after the exercise has come to an end. A similar remark applies to singing : a practised singer will never become breathless after singing, hence the curve in such cases will return immediately parallel with the normal. In singing, however, a marked difference was observed in the breathing when standing and when sitting. The tracing obtained in the latter position resembles the "forced breathing" curve almost exactly, which is not the case when standing, so that the erect position is the correct one for singing.

Another fact of interest to athletes and people who run for their trains was demonstrated. It was found that if on sitting down after "stepping exercise" one or two deep breaths were taken immediately, the breathlessness passed away at once, because the carbonic acid accumulated in the blood was thus got rid of. It follows from this observation that in case of extreme breathlessness, as would occur after running for a train, great relief would be experienced from taking a few deep breaths.

Some novel experiments were made by Dr. Marcet on the effect of the exercise of the will on respiration. The person under experiment sat down in a chair, and imagined himself to be engaged in some form of physical exercise, such as running after somebody up a hill or rowing against the tide. Whilst his imagination was at work the air from his lungs was collected and the recording instrument set going. The tracing obtained was not that of natural breathing, but resembled the "forced breathing" curve, followed by the same pause that is always observed after forced breathing. It must be remembered that the breathing was not forced intentionally, and after a long series of experiments Dr. Marcet has come to the conclusion that an increased supply of oxygen is actually needed by the brain centres that are at work. This would take too long and is too technical a matter for us to go into here, but full particulars will be found in the third of the Croonian lectures, published in the *Lancet* and *British Medical Journal* for 1895. The question will be considered also *in extenso* in a book by Dr. Marcet now in the press.

## THE REV. FRANCIS WOLLASTON, AMATEUR ASTRONOMER.

By W. T. LYNN, B.A., F.R.A.S.

THE Rev. Francis Wollaston was for nearly half a century rector of Chislehurst, in Kent, where he made a considerable number of useful astronomical observations. It is an interesting circumstance that the list of Fellows of the Royal Society in 1815 and a few previous years includes the names of this astronomical amateur and of three of his sons ; one of the latter the celebrated chemist, and another the Rev. F. J. H. Wollaston, for some years Professor of Natural Philosophy at Cambridge, and afterwards Archdeacon of Essex, and vicar of South Weald, in that county. Francis Wollaston was born on the 23rd of November, 1731. He was the eldest son of Francis Wollaston, of Charterhouse Square, and grandson of William Wollaston, the author of that well-known work, "The Religion of Nature Delineated." Young Francis was sent to Sidney Sussex College, Cambridge, in the month of June, 1748, and two years afterwards was admitted to Lincoln's Inn with a view to entering on a legal career ; but conceiving a distaste for it, because he saw that barristers took any side for their clients, whether right or wrong, he returned to Cambridge, graduated LL.B. (since it was too late to take a degree in arts in the regular course), and entered into orders, being ordained deacon in 1755 and priest in 1756. In the latter year he returned to his father's house, and undertook the Sunday morning preaching at St. Ann's, Soho, for Dr. Squire, afterwards Bishop of St. David's. In the summer he married Miss Althea Hyde, fifth daughter of Mr. John Hyde, of Charterhouse Square, soon after which he was instituted to the rectory of Dengey, in Essex. In 1763 he obtained the living of East Dereham, in Norfolk (where William Hyde, his second son, was born in 1766), which he held until 1769, when he was collated to the rectory of Chislehurst, in Kent, where he remained until his death forty-six years afterwards, zealously discharging all the duties of a parish clergyman amongst a small country population. The liberality of his mind towards those who differed in doctrinal views led him to take rather a prominent part in an agitation respecting relief in the matter of subscription to the Articles, which caused him to be unjustly suspected of a tendency to Socinianism. In consequence of this, and the abortiveness of the attempt about subscription, he determined to enter no more into controversial matters, but devote his leisure to the study of astronomy. His earliest recorded astronomical observations were, I believe, those of occultations and other phenomena made in 1775, and published with later ones in the *Philosophical Transactions for 1784*. In the following year he contributed a paper (read April 7th, 1785) to the Royal Society on "A

Description of a New System of Wires in the Focus of a Telescope for observing the comparative Right Ascensions and Declinations of Celestial Objects." Next year (1786) he was elected a Fellow of the Society, and communicated a paper containing observations of a comet which had been discovered by Miss Herschel on the 1st of August in that year, and which he observed during August and September. We do not meet with any other papers of his until 1793, when he communicated on May 9th a "Description of a Transit Circle for determining the Places of Celestial Objects as they Pass the Meridian;" and after this the results of his astronomical observations appear in separate works. The *Fasciculus Astronomicus* was published in 1800, and contains an extensive catalogue of northern circumpolar stars, with some account of the transit circle (described in the paper just mentioned) with which the observations were made; also of a portable altitude and azimuth instrument made for the author by Templeton, and various tables used in astronomical calculations. The observations were made in the years 1794–7, and reduced to the beginning of 1800. The author also took the trouble of comparing them with places deduced from observations made by Flamsteed, Hevelius, and earlier astronomers, and points out a mistake fallen into by Flamsteed in giving the date 1463 to the catalogue of Ulugh Beigh. The date assigned is 841 of the Hegira, which took place in A.D. 622; but as the mean Mohammedan year (allowing for the intercalary years) consists of 354·366 days only, eight hundred and forty-one of their years amounts to only about eight hundred and sixteen of our calendar years, so that 841 of the Hegira corresponds most nearly to A.D. 1488. Wollaston had published some years before a "Specimen of a General Catalogue of Stars, arranged in Zones of North Polar Distance." In that he had inserted some notes on double stars by Herschel, who, it appears, objected to the abbreviation (from want of space) of these; therefore, in the *Fasciculus* all such particulars are omitted, references only being given, as before, to Herschel. In closing this account of Wollaston's astronomical work, we need only further mention his star-maps, published in 1811 (when the author was eighty years of age), from observations extending over several years, under the title, "A Portraiture of the Heavens." It is remarked that some of them were found useful in observing the comet of 1807. Wollaston died at Chislehurst on the 31st of October, 1815, in the eighty-fourth year of his age. The *Gentleman's Magazine* for February, 1816, contains a short appreciative obituary notice of him.

## THE TOTAL ECLIPSE OF AUGUST 9, 1896.

By E. WALTER MAUNDER, F.R.A.S.

IT is difficult to write a satisfactory account of an eclipse expedition to which a sight of the eclipse has not been vouchsafed, and, as all the world now knows, that has been our fate at Vadsö.

Nevertheless, there is a story to tell, though but a meagre one compared with that for which we had hoped. The various preparations for drawing and photographing the corona and for photographing the spectrum were necessarily of no avail, and it would appear useless to recount again the details of programmes which the weather defeated. Something, however, was done. The general spectacle of the eclipse was watched with sedulous care by scores of observers, most of whom, under more fortunate circumstances, would have had their whole attention fixed upon their instruments; so, though thick clouds concealed the sun almost without a break for the whole period of the eclipse, yet the weird effects of the gradual darkening were watched with great minuteness. The edge of the shadow was distinctly seen by several observers as it swept upwards from the south, some observing it on the clouds, others on the hills and fjord. The shadow appeared to travel from the south, not from the west—the direction in which the track of totality really lay—this effect being due to the oval shape of the shadow itself, and the fact that the central line was south of Vadsö, where the observers were stationed. With the sweep of the shadow across the country there came a distinct increase in the darkness, an increase so distinct that it was possible to assert with great confidence that the predicted time of the commencement of totality, as given by the *Nautical Almanack*, is quite four seconds too late; the duration would appear to be practically correct, as the return of light—more sudden and more easily marked, in the opinion of nearly every observer, than the accession of darkness—took place about three seconds before the tabular time.

Regarded from the point of view of actual amount of illumination the darkness was not excessive; it was probably less than in any recent eclipse—less even than it would have been had the sky been clear. It was perfectly easy to read the seconds hand of a watch even at mid-eclipse, distant objects were still retained in sight, and the surrounding features of the country did not entirely lose their colour. The total light did not probably differ very much from that of a bright night at the full of the moon, but the impression produced was of a totally different character. Instead of the cold but cheerful light of the moon—a light felt to be beautiful and helpful—the light of the eclipse could only be regarded as darkness, a terrible darkness, darkness made visible, darkness that might be felt.

It is not possible to explain exactly the cause of this feeling, one which the most stolid and the most cynical were alike obliged to confess to. Possibly the speed with which it came on, continually and inexorably increasing without any obvious cause, had something to do with it. Possibly it may have been rather due to the strange colouring of earth and sky, for, above, the heavy clouds which almost entirely covered the heavens were dyed a deep purplish black; below, the dark rocks took a hue as sombre and deep, though perhaps of a more bluish tone; whilst in the few narrow rifts, especially immediately below the sun, in the east and away between dips in the hills to the north-west and south a bright amber light appeared. It was as if a funeral pall with a golden fringe had been laid upon the face of nature.

The effect of the darkness upon men and animals was the same, as has been so frequently noticed in other eclipses wherein the sky has actually been clear. The birds flew home straight and low and with shrill cries of terror as the gloom deepened. The goats on the island of Vadsö, where the British Astronomical Association were encamped, whose restless curiosity had made them a sad plague to the party during the previous week, hid themselves in the hollows of the rocks and lay down to rest, and all conversation amongst the large crowd of onlookers entirely ceased. Even a little band of obstreperous Germans from the *Erling Jarl*, who had made themselves offensive by their disorderly conduct before the eclipse began, were awed into silence, and the most profound stillness prevailed until the return of light.

No stars were seen in any of the small breaks which the clouds afforded. Indeed, these looked far too bright for any such to have been seen.

Nothing is more difficult than to give such a description

XUM

of the appearance of the light during totality as to enable those who have not seen an eclipse to realize it. One observer speaks of "sea, sky, and hills all becoming an intense livid blue"; others preferred to call it the "deepest indigo purple" they had ever witnessed; others again differentiated between the tone of cloud and land, and spoke of the former as being of a "cold dark-grey black," whilst the hills retained in their blackness some tinge of blue or purple. But there was a general opinion that the colour of the amber and ruddy rifts were not only like "sunset colours," but had identically the same origin. Mr. Green urges that the golden light so conspicuous at sunset is always present at its proper low altitude in the sky; it is only that it becomes more conspicuous when the daylight fades as the sun sinks below the horizon. On this hypothesis there is no need for wonder that the amber and ruddy tints seen in the low-lying rifts appeared so vivid. This would naturally follow as an effect of contrast with the dark masses of cloud and rock above and below them.

And now for the lessons of the eclipse, for though we were not fortunate enough to see it, our experiences have their lessons.

First of all, the fact that a magnificent view was afforded at Bodo, where the small altitude of the sun rendered success so unlikely, whilst at Vadsö, and at Bugonæs, where the chances seemed reasonably good, the eclipse was hidden by clouds, reinforces and drives home the lesson taught by a dozen previous eclipses, that no accessible station whatsoever must be left unoccupied; and that those who are sufficiently self-denying as to adopt a location apparently hopeless, may, in spite of meteorological reports, carry off the prize even before those who have stationed themselves where all seemed promising.

Another lesson, not less important, is that of the value and necessity of drill. The work accomplished by Prof. Lockyer and his assistants at Syd Varanger was most remarkable, and calls for very full recognition. The organization of practically an entire ship's company as an observing staff, and their training into a state of thorough preparedness, was a most remarkable achievement.

If Mr. Lockyer's achievement was surpassed, then I think the British Astronomical Association may lay claim to that merit. In many ways the task before the officers of the Association was a far heavier one than that before Prof. Lockyer. The number of observers to be brought into line was considerably larger, and these were not naval officers well accustomed to strict discipline and exact obedience, but independent ladies and gentlemen out on a holiday excursion. Nevertheless the task was accomplished. The observers were organized, trained, and exercised, and on the morning of the eclipse each was in his or her appointed place, knowing what to do, and confident, from the rehearsals that had taken place, as to their ability to accomplish it. That this was possible was due, first, to the unsparing earnestness of those undertaking the work of organization—Dr. Downing, Messrs. Crommelin, Evershed, Green, and Lunt Wesley, and the Rev. J. Cairns Mitchell—and, next, and not less, to the most cheerful and ready co-operation and help, not only of those who had come out expressly as observers in connection with the British Astronomical Association, but also those who had come merely to make a holiday, and to see an unwonted spectacle.

Lastly, I think that it is clear that the equatorial in its ordinary form will be less and less the eclipse instrument of the future. In some cases the most convenient device will be that adopted by Prof. Schaeberle, in 1893, and by Dr. Copeland on the present occasion, of a fixed telescope and a travelling plate, the motion of the plate being regulated to compensate for the motion of the sun. In many respects, a better way of getting over the difficulties of a fixed telescope is by the use of an auxiliary mirror, mounted in one of several ways. The ordinary heliostat has the drawback that it is not suitable for any but very short exposures, on account of the apparent revolution of the image. The double heliostat overcomes this difficulty, but at the cost of a second deflection. The polar heliostat requires the telescope to be parallel to the polar axis, often a very inconvenient arrangement. On the whole, the cœlostatic method, employed for the first time in this eclipse, appears to offer great possibilities, and will probably obtain greater favour as time goes on.

For those, however, who have only small instruments at their disposal, and especially cameras in which the focal length is small and the aperture relatively large, there can be no doubt that the best plan, in default of the assistance of a cœlostat or its equivalent, will be to fix the instrument rigidly pointing to the sun, to dismiss all idea of following, and to limit the exposures, so that the blurring due to the apparent motion of the sun would not be appreciable in the time.

The above remarks apply, of course, only to photographs of the corona itself. The inner portions of the corona are so bright, and the best modern plates so sensitive, that an exposure practically instantaneous is sufficient to obtain a good record. The experience of former eclipses shows that the tendency has been distinctly to over-expose—even with the less rapid plates formerly available—and, indeed, save under the most exceptional conditions of sky, a limit is soon reached in which further exposure, instead of bringing up more coronal features, only brings up the general sky illumination. It has become, therefore, clear that short exposures must be the rule, and, if short, there is the natural desire to obtain as large a number of these as possible. The crucial question then becomes, how to obtain the greatest possible number of exposures, without, in the process of changing plates, setting up such tremors as will destroy all definition? To effect this it is of first necessity that the telescope itself be as stable as possible, and this can be far better secured where it is immovably fixed than where it is equatorially mounted and driven by clockwork.

As to the methods of changing plates, there seems little advantage in one over another. Perhaps the method which promises best is that of a separate dark slide for each plate, the dark slide being made to rest on the end of the camera, not to fit into a tight groove—to be held in its place by an easily moved spring, and the shutter of the slide to open door fashion. The changes in this case will probably be made as quickly, if not more so, than by any arrangement of changing boxes, revolving drums, or long continuous slides; it will be much less weighty, less liable to jar, and free from all possibility of sticking at a critical moment.

For spectroscopic work, the conditions are quite different, and vary with the different departments of work to be attempted. Here the equatorial may still hold its ground, though the balance of convenience will be greatly on the side of the cœlostat.

Lastly, the one great lesson which the disappointment of Vadsö seemed to enforce upon all those who suffered from it, was to leave no stone unturned to secure that they should take part in the observation of the next solar eclipse, that visible in India in January, 1898, whence, so far as mortal can foresee, there will be little or no fear of the untoward weather that baffled our efforts in Finmark.

XUM

**PHOTOGRAPH OF NEBULOSITIES NEAR ANTARES AND NU SCORPII.**

Taken by Professor E. E. BARNARD, at the Lick Observatory, Mount Hamilton, California, on June 21—22, 1895. Exposure, 7h. 30m.

## EXTENDED NEBULOSITY ROUND ANTARES.

By Prof. E. E. BARNARD, F.R.A.S.

IN the *Astronomiche Nachrichten*, Band 138, Nr. 3301, I have given an account of a great nebula near Antares, which is shown on my photographic plates of that region, made with the Willard lens of the Lick Observatory in the spring of 1895.

Several photographs of this nebula were secured during the season of its visibility in that year. These pictures show that the sky at that point is quite as extraordinary as the nebula itself. Indeed, the stratum of stars, the long vacant lanes, and the nebula are all so apparently connected that one can hardly doubt that there is an actual connection existing here, and that these objects are but different features of the same phenomenon; that is, the nebula, the vacant lanes, and the sheeting of stars appear all to be at the same distance and intimately connected.

From the accompanying photographs it will be seen that the condensations in this nebula occur at certain bright stars—Rho Ophiuchi, 22 Scorpii, and others. From this it is certain that these stars are at the same distance as the nebula, for they form part of it. By inference it would therefore appear that these bright stars are at the same distance as the stratum of small stars through which these vacant lanes run.

If this is so—and it seems reasonable—these photographs prove what I have held to be the case for many years: that the stars which make up the general structure of the Milky Way are comparatively very small bodies, and that they consequently differ vastly, in point of size at least, from the ordinary stars of the sky.

The original negatives show that Sigma Scorpii and Antares are also connected with this great nebula by fainter nebulous extensions, though they are not centres of condensation. It would seem, therefore, that not only are the Milky Way and the nebula here at the same distance, but that many, if not all, of the bright stars in this region are also at about the same distance from us.

The late lamented A. C. Ranyard, formerly editor of KNOWLEDGE, and one of the brightest minds that have adorned the astronomy of to-day, long held that the general stars of the Milky Way were smaller than the average stars of the sky elsewhere. The photographs which I have obtained of the various parts of the Milky Way, I think, prove this in many cases, but in none so emphatically as in these pictures of the Antares region.

One feature about this nebula that seems to distinguish it from the other great nebulosities of the Milky Way is the fact that it strongly condenses about these several bright stars (Rho Ophiuchi, 22 Scorpii, and the two small stars Cord. Dur. −24° Nos. 12683-4), and thus shows unmistakably its connection with them. The other great nebulosities of the Milky Way seem to be mixed freely with the stars, and not to condense about any individual star. Even in the case of the condensation of the great nebulosity of 15 Monocerotis, though it is denser at the several bright stars it does not actually condense *at* any one of these stars. In its manner of condensation at the several bright stars, the great nebula of Rho Ophiuchi resembles the nebula of the Pleiades, for there is an actual condensation at bright stars, and not alone a simple involving of the stars within the limits of the nebula. I have previously called attention to this peculiarity of mixtures of stars and nebulæ in *Astronomy and Astrophysics*.

"There is one point, however—and it may be an important one—where the Pleiades differ from the rest of these nebulous clusters. In its case the nebulosity is condensed about the individual stars; in nearly all the other clusters referred to the nebulosity does not seem to attach itself to any individual star, but simply to involve the group, the stars themselves not showing any special tendency to condensation individually."

I think this peculiarity of condensation or non-condensation is an extremely important one, and well worthy of special attention from those who are interested in such subjects.

In the original photographs of the Antares region there are different degrees of darkness in the vacant lanes that run easterly from the nebula.

*There are dark holes in these vacancies.*

This would seem to show that all this region—lanes and star areas—is covered with a vast diffusion of nebulosity, and these darker places in the vacant lanes are thin places or holes in this nebulous veiling. However unexplainable these features may be, they are real, and are verified by the different negatives. Indeed, I believe that all this region, as far east as Theta Ophiuchi, is covered by a vast sheeting or substratum of nebulosity. Still east of this is another region where the Milky Way is of a nature wholly different from any other part—that is, it looks like neither stars nor nebulosity, and I believe that, in the ordinary sense of the words, it is neither.

On the upper part of the unenlarged picture of this region, the star $\nu^2$ Scorpii is shown to be in a great wing-like nebula—a very remarkable object and unknown previous to the making of these photographs. This nebula does not condense about $\nu^2$, but extends from it great wings of light. I think I can trace diffusions of this nebula to a connection with the great nebula of Rho Ophiuchi. It is certainly connected with the nebulous mass that is seen to surround the two stars B.D. −19° No. 4358 and −19° No. 4361 (this last star is 1855·0, 16h. 12m. 1s. −19° 46′).

With a one-and-a-half-inch lantern lens the great nebula of Rho Ophiuchi is shown to extend in a feeble diffusion to several degrees south and west of Antares and Sigma Scorpii.

The position of Rho Ophiuchi, Yarnall$_3$ 6970 for 1860·0, is in $\alpha = 16$h. 17m. 12s., $\delta = -23°\ 7'$. $\nu^2$ Scorpii, Yarnall$_3$ 6810 for 1860·0, is $\alpha = 16$h 3m. 52s., $\delta = -19°\ 6'$.

It would seem that these stars, which are shown to form a part of this great nebula, should be productive of extremely interesting results if investigated with the proper spectroscopic apparatus.

It will be seen that the great nebula occupies a vacancy here among the thickly strewn stars. From this vacancy dark lanes, with singularly abrupt and well-defined edges, run easterly for many degrees. One of these lanes runs in a broken manner as far east as Theta Ophiuchi, and, sweeping around that star, turns under it westward again, as shown in the photograph published in KNOWLEDGE for November, 1894. (*See also* the *Astrophysical Journal* for December, 1895.)

I have before called attention to the fact that these great nebulæ of the Milky Way either occupy a vacancy among the stars or are on the edges of such a vacancy—such nebulæ, for instance, as the great nebula near $\alpha$ Cygni, that of 15 Monocerotis, the one near $\xi$ Persei, and the present one near Antares. This is a very significant fact, that deserves careful attention.

## Notices of Books.

*The Elements of Physics.* By Edward L. Nichols and William S. Franklin. Vol. I., Mechanics and Heat. Pp. 228. Illustrated. (New York: Macmillan & Co.)

XUM

The necessity of a good knowledge of mathematics in the proper study of physics is illustrated by the fact that the present volume, called with somewhat doubtful policy "The Elements of Physics," requires a knowledge of the calculus, and does not shirk the difficulties of the subject in the way that ordinary text-books usually do. In Part I. the subjects treated are physical measurements; physical quantity; laws of motion, falling bodies, projectiles; harmonic motion, statics, energy; moment of inertia, the pendulum; elasticity, friction of solids; hydromechanics; and chemical physics: while Part II. includes chapters on thermometry; calorimetry; the properties of gases, and thermo-dynamics. The regions of electricity and magnetism and of sound and light have been allocated to two other volumes. The distinctive features of this book are the systematic way in which the principles of physical science are developed, the conciseness of the statements made, and the fundamental accuracy of the various proofs and demonstrations described. Advanced students of physics will have little difficulty in working through the volume, and they will find that by so doing they will not only bind their ideas more firmly together but will also extend their knowledge. The authors seem to hold that students of physics should first read text-books and attend lectures and demonstrations, and finally make physical measurements in the laboratory. This may be the proper plan for students in colleges of University rank, though we doubt whether it is an ideal one. Lectures and demonstrations may make mathematical physicists, but the best way to foster investigation is to begin with laboratory work instead of ending with it.

*A Compendium of General Botany.* By Dr. Max Westermaier. Translated by Dr. Albert Schneider. Pp. 299. Illustrated. (New York: John Wiley & Sons. London: Chapman & Hall, Limited.) So many good scientific handbooks are translations from the German that it is a wonder the cry "Made in Germany" has not been applied to them. Especially is this the case with biological and psychological works, and scarcely a month passes without the appearance of two or three of them. The reason is not far to seek: German scientific men have an infinite capacity for collecting facts, and for piling up information into *Lehrbücher*. Prof. Westermaier's work is not perhaps so diffuse as others from the Fatherland, and students of botany will certainly be grateful for Dr. Schneider's translation of it. It is truly a compendium of general botany, and its value as a text-book lies in the logical and scientific treatment of the subject-matter. The arrangement adopted testifies to this; it is as follows:—(I.) The cell. (II.) Tissues: (*a*) structure of tissues and simple organs; (*b*) differentiation of tissue. (III.) Systems of organs. (IV.) Reproduction. (V.) General chemistry and physics of plant life. (VI.) System of plant classification. To the necessarily limited text on these matters numerous references to standard authors are added, as an inducement to the student to extend his reading. The work was written for use as a text-book of elementary instruction for German *Hochschulen*, which are, as is well known, far in advance of our own high schools. Dr. Schneider's translation is a readable rendering of the original, and we have no doubt it will do good service to botanical science.

*Text-Book of Comparative Anatomy.* By Dr. Arnold Lang. Part II. Translated into English by H. M. Bernard, M.A., and Matilda Bernard. Pp. 618. Illustrated. (Macmillan.) The first part of this translation of Prof. Lang's work appeared in 1891, and it is to be regretted that there should have been so much delay in the completion of the work. The delay is partly due to the tardy issue of the concluding parts of the German edition, and partly to the great difficulty in giving a faithful and fluent rendering of the original. The present volume deals with the Mollusca, Echinodermata, and Enteropneusta, and the entire work forms a text-book of the comparative anatomy of the invertebrata. But the phyla described in the volume under notice are treated much more comprehensively than is usual in text-books—so elaborate, indeed, are the chapters on the Mollusca and Echinodermata, that they constitute valuable treatises on these groups of the animal kingdom. The text is lavishly illustrated, and the majority of the cuts are new. Prof. Lang has adhered to his method of excluding from the descriptive text the names of the authors whose observations and statements he has used in the construction of his work. In place of this a list of works consulted, and bearing upon the subject, is given at the end of each chapter. Some dissatisfaction was expressed at this departure from the historical method when the first part of the translation appeared, and the adverse criticism then aroused applies equally well to the volume before us. In a work of this character, references to papers and authors should be given in footnotes, so that students may know exactly where to seek further information upon any particular point described. No bibliography can entirely compensate for the omission of such finger-posts to fuller knowledge. This point aside, it is almost unnecessary to tell zoologists that Prof. Lang's book is of a high order of excellence, and that the translators have very successfully put it in English dress.

*A Dictionary of the Names of Minerals, including their History and Etymology.* By Prof. Albert H. Chester. 8vo, cloth, 15s. net. (Chapman & Hall.) In this work the author has endeavoured to give the history and etymology of every mineral name, including the following points:—1st, the name correctly spelled; 2nd, its author; 3rd, a reference to its first publication; 4th, its original spelling; 5th, its derivation; 6th, the reason for choosing this particular name; 7th, a short description. These particulars are fully given in most cases, but a number remain incomplete, and a list of such is given in the hope that information may be elicited, to be used in a subsequent edition.

*Chemistry in Daily Life.* By Dr. Lassar-Cohn. Translated by M. M. Pattison Muir. (H. Grevel & Co.) Illustrated. 6s. Mr. Pattison Muir, in his preface to the translation, says that when Dr. Lassar-Cohn published these lectures in book form they caused quite a stir in German circles; and we are pleased that he has undertaken the work of putting the book into English. Although the subject matter is very disjointed, the author has certainly managed to give an account of the chemistry of manufactures of substances used in daily life in a way which would be intelligible to a reader who had no knowledge of chemistry. It is surprising, when one thinks of it, how much the chemical arts at the present day are interwoven into our daily life, and a book of the character of the one before us cannot therefore fail to be of interest to the general reader. When we mention that argon, X rays, bimetallism, cordite, colour photography, incandescent gaslights, all receive appropriate treatment, sufficient proof is surely advanced to show that the book is popular and up to date.

*Outdoor Life in England.* By Arthur T. Fisher. (Bentley & Son.) This book is a series of chatty sketches of natural history and sport—chiefly the former. The author conveys his information in a very pleasant way; and although he tells us that he does not pose as a naturalist, yet his knowledge of nature is both extensive and sound. He writes of many things—animals, birds,

fish, plants, shooting, hunting, fishing, and poaching. We may mention that the black rat (*Mus rattus*) is not so rare as laid down by Mr. Fisher, who says, "I very much doubt if it would be possible to procure a single specimen of this rat at the present time." The book, as a whole, is excellent, and deserves every praise as a popular work on our outdoor life.

*Introduction to the Study of Fungi, for the Use of Collectors.* By M. C. Cooke, M.A., LL.D., A.L.S. Pp. 360. Illustrated. (A. & C. Black.) Students of mycology know that a work by Dr. Cooke is always a desirable possession, and the confidence they have in his productions will induce them to add this volume to their libraries without considering the evidence of reviewers as to its value. And their action would certainly not give them cause for regret in the present instance. No work that we know of gives a better account of the distribution and classification of fungi, and in none is the organography described with greater regard for the interests of students. The illustrations are instructive and sufficient, and though many of them are old friends they are none the less truly helpful adjuncts to the text. A serviceable bibliography is given at the end of each chapter, and these, with the footnotes, will be appreciated by inquiring minds. The work, as a whole, is a valuable introduction to the systematic study of fungi, and it supplies an acknowledged want. We regret to note that Dr. Cooke says of it: "It is probably my last contribution of any importance to British mycology."

Branched Carpophore of *Peronospora*. From Dr. Cooke's *Study of Fungi* (A. & C. Black).

*The Astronomy of Milton's "Paradise Lost."* By Dr. Thomas N. Orchard. Pp. 338. Illustrated. (Longmans, Green, & Co.) Of all the sciences, astronomy best lends itself to poetical description. A glance at the heavens when stars are sparkling on the black infinitude of space is sufficient to inspire anyone, while knowledge of the simple laws obeyed by celestial bodies in their motions gives the poetic fancy still wider scope. Dr. Orchard, by bringing together the astronomical allusions in Milton's "Paradise Lost," has added a choice work to the literature in which cultured men find pleasure. Milton possessed a comprehensive knowledge of astronomy, and this enabled him to rise to lofty flights in his sublime poem. Though he was conversant with the Copernican system, and appeared to be convinced of its truthfulness, he selected the Ptolemaic cosmology as the scientific basis upon which to construct his poem, thinking, perhaps, it was better adapted for poetic description. How very proficient he was in the astronomical knowledge of his day is clearly shown by the extracts from "Paradise Lost" given by Dr. Orchard. The title of the book hardly expresses the scope of the contents. At least one-half of the text is made up of descriptions of astronomical objects and phenomena—instructive in every sense, but not directly connected with the subject. We suggest to Dr. Orchard that his volume should have borne some such title as "Celestial Systems and Objects, with Astronomical Allusions in 'Paradise Lost'"; at any rate, the Miltonic description of the book should only form a sub-title.

*British Moths.* By J. W. Tutt, F.E.S. (Routledge.) Illustrated. Written for young entomologists, this forms an excellent book for the beginner. Besides giving a good description of the moths and larvæ, the author tells when and where and how to find them, and also explains very lucidly the phraseology in use in connection with the study of entomology. Some sound advice is given to the would-be student of the Lepidoptera, and the book forms quite the best guide and companion that we know to the youthful collector, and as such we would heartily recommend it. The illustrations are not of course so good or extensive as those in more elaborate books, but the coloured plates, together with the cuts in the text, are all that is needful in a first book.

## BOOKS RECEIVED.

*New Ground in Norway.* By E. J. Goodman. With Illustrations from Photographs by Paul Lange. (Newnes.) 10s. 6d.

*Other Suns than Ours.* By Richard A. Proctor. (Longmans.)

*Results of Rain, River, and Evaporation Observations made in N. S. W.* By H. C. Russell, B.A., C.M.G., F.R.S. (Sydney: Charles Potter.) 3s. 6d.

*Skertchly's Physical Geography.* (Murby's Text Books.) 1s.

*The Reign of Perfection.* By Walter Sweetman, B.A. (Digby, Long, & Co.) 3s. 6d.

*The Site of Camulodunum.* By I. Chalkley Gould. (Marlborough & Co.)

*British Mosses, Students' Handbook of.* By H. N. Dixon, M.A., F.L.S., and H. G. Jameson, M.A. (John Wheldon & Co.) 18s. 6d.

*Artistic Landscape Photography.* By A. H. Wall. (Bradford: Percy Lund & Co., Ld.)

*Navigation and Nautical Astronomy.* By F. C. Stebbing, M.A. (Macmillan.) 8s. 6d.

*Astronomical Observations and Researches made at Dunsink.* (Dublin: Hodges, Figgis, & Co.)

*Modern Astrology for August.* (Bouverie St.) 1s.

*Ocean Rainfall, with Chart and Tables.* By W. G. Black, F.R.M.S. (2, George Square, Edinburgh.)

*The Junior Salon.* (Percy Lund & Co., Ld.) 6d.

*Science Progress for August.* (Scientific Press, Ld.) 2s. 6d.

*Photo-Trichromatic Printing.* By C. G. Zander. (Raithby, Lawrence, & Co., Ld.)

We have received a very useful illustrated catalogue of surveying and drawing instruments from Messrs. T. Cooke & Sons. It contains, among other things, details of a new Tacheograph, which consists of a combination of a tacheometer and a plane table, the joint invention of Messrs. Victor de Ziegler and Charles Hager. One of these instruments has been recently supplied to the Indian Government for the purpose of experiment and trial. Messrs. Cooke's patent reversible level still holds its own, we believe, as one of the most reliable instruments. The catalogue contains details of many other instruments, besides a very useful appendix, consisting of two descriptive chapters on the adjustment of their levels and theodolites.

## Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

### THE THEORY OF THE TIDES.

*To the Editors of* KNOWLEDGE.

SIRS,—I have read with interest the letters of your correspondents on the subject of tides, and I cannot help thinking that, although the details of tidal phenomena are doubtless very complex owing to the numerous causes at work, the difficulties of explanation of the outlines of the main phenomena have been somewhat exaggerated.

Sir John Herschel, in his "Outlines of Astronomy," says, when speaking of the tides, that "many persons find a strange difficulty in conceiving the manner in which they are produced. That the sun, or moon, should by its attraction heap up the waters of the ocean under it, seems to them very natural. That it should at the same time

heap them up on the opposite side seems, on the contrary, palpably absurd. The error of this class of objectors . . . . consists in disregarding the attraction of the disturbing body on the mass of the earth, and looking on it as wholly effective on the superficial water. Were the earth indeed absolutely fixed, held in its place by an external force, and the water left free to move, no doubt the effect of the disturbing power would be to produce a single accumulation vertically under the disturbing body. But it is not by its whole attraction, but by the difference of its attractions on the superficial waters at both sides, and on the central mass, that the waters are raised."

He then goes on to say that it has been found by calculation that the moon's maximum power to disturb the waters on the earth is about one 12,560,000th of gravity, which would be sufficient to make a difference of about fifty-eight inches between high and low water; the power of the sun being about two and a half times less, or about twenty-three inches.

Your correspondent, Mr. J. Creagh, seems to be under the impression that if two forces are acting in opposite directions on a body, that body would act as though it were affected solely by the more powerful of the two forces, instead of acting as though it were affected by a force equal to the excess of one of the forces over the other. Otherwise he would scarcely say that "the authors" (to whom he frequently refers, but never by name) "fail to see that the tidal power of the moon, being almost infinitesimal compared to the earth's gravity force, could raise towards herself in direct opposition to gravity neither a particle of water, nor a grain of sand, nor any portion of matter, small or large."

This is with reference to the "suction theory." That which he calls the slip theory" he dismisses on the same grounds.

In his "weight theory" I do not perceive how, by "descending to the application of the idea," he arrives at the conclusion that "in order to account for a rise of only three feet in their height, a depth of water of between three thousand and four thousand miles would be required."

G. H. HILL.

*To the Editors of* KNOWLEDGE.

SIRS,—Will you kindly allow me to add a few remarks to what I have already said upon the interesting problem of the tides?

A satisfactory solution might be arrived at, or at any rate greatly facilitated, if philosophical writers were to definitely state from what source the tides derive their dynamical energy. From the text-books it is difficult to say whether they derive their energy from the moon, or the moon and the sun combined, or from the earth's rotation; such is the ambiguity of the language used and the obscurity of the ideas entertained by different authors. I may be thought pedantic for not accepting without demur the dictum of men much more learned than myself, and for having an opinion of my own; but I firmly believe that the tides cannot derive any dynamical energy from an inert body like our satellite, neither can I believe that two such dissimilar bodies as the sun and moon have a similar physical and mechanical effect upon the ocean. No doubt the sun—unlike the moon—does have a dynamical effect upon the ocean by means of its heat, but this manifests itself in the form of currents flowing from the tropical to the polar seas, and are movements totally distinct from and different to the tides.

Although the moon is a source of no dynamical energy to the earth, the latter body may be a source of energy to the moon, and by its diurnal rotation may also cause the tides, the centrifugal force acting more powerfully upon the liquid and mobile ocean than upon the earth's solid crust.

"We cannot account," as Mr. Proctor says, "for the moon's peculiarity of rotation, without regarding it as due to the earth's controlling influence"; and this belief is confirmed by the singular coincidence that the energy of the tides and the velocity of the moon's motion vary concurrently and in a precisely similar manner, proving that the tides and the moon's motion in her orbit must have a common cause. What else can this cause be than the earth's centrifugal force?

In conclusion I would draw especial attention to the remarkable correlation that exists between the height of the tides and the lunar variation. This synchronism—that the highest tides (the spring tides) should occur when our satellite is in syzygy, and moving at her greatest speed, and that the lowest tides (the neap tides) should occur when the moon is in quadrature, and moving at her slowest speed—is most significant, and must have an important bearing upon the causation of the tides, although it is overlooked or ignored by every author that I have come across who deals with the theory of the tides.

H. A. COOKSON.

## A LUNAR RAINBOW.

*To the Editors of* KNOWLEDGE.

SIRS,—On the night of June 27th last—a cloudy, dark night—I was sitting in the verandah of my quarters, when, just as rain, which had been imminent for some time, began falling, I was astonished by seeing a distinct band, which emanated from a patch of light cloud and fell in the shape of a rainbow into a tank of water in front of my house. The moon was shining brightly at the time, and on watching the band I distinctly noticed that it had a dark reddish appearance on the outside edge and was of a bluish-green tinge elsewhere. There was also a reflection appearing of a uniform whitish hue.

I first noticed the lunar rainbow, as I believe it to be, at 9.48 P.M., and watched it carefully till its disappearance at 10.1 P.M.

The outer arc or reflection disappeared almost immediately, and the rainbow, as it receded, appeared for a short space as of a uniform bluish-green hue, and finally, before its disappearance, seemed to me of a whitish hue like the outer arc at the commencement.

R. J. D. SAIR, Lieut.,
Bhamo, Upper Burma. 30th (5th Burma Bn.) M.I.

## SOME CURIOUS FACTS IN PLANT DISTRIBUTION.—IV.

By W. BOTTING HEMSLEY, F.R.S.

WITH the exception of a brief account of the new vegetation of Krakatoa, I have so far only given some particulars of the plants inhabiting a few of the remote islands of the temperate and frigid zones of the southern hemisphere. The countless islands of the Pacific Ocean within the tropics, as well as the comparatively few remote isolated islands in the Atlantic and Indian Oceans, are no less interesting from a botanical standpoint—to say nothing of their animal inhabitants. The Seychelles group in the Indian Ocean is specially so. These islands, upwards of thirty in number, are situated about six hundred miles to the north-east of Madagascar; the largest being seventeen miles long and five in average breadth, with an altitude of nearly three thousand feet. Formerly most of the islands were covered with forest, the

greater part of which has disappeared before cultivation and fires. Still, sufficient is left in the less accessible places to give an idea of the composition of the aboriginal vegetation. Some three hundred and fifty species of flowering plants and ferns are recorded from the islands, one-sixth of which have not been found elsewhere. Palms and screw pines constitute the most striking features in the vegetation; the former, indeed, exhibiting a more numerous and varied development than in any similar situation in the world. The only approach to it is in Lord Howe Island, a speck of land less than a quarter of the size of the Isle of Wight, situated in mid-ocean, about three hundred miles from the coast of New South Wales. This island, however, is some ten degrees out of the tropics, yet it produces four species of palms peculiar to itself. It is probable that Eastern Polynesia formerly possessed a more varied palm vegetation than at present, because, apart from the universal coconut, individuals of several other kinds are now of rare occurrence, whilst others may have disappeared altogether.

But to return to the palms of the Seychelles, which, I may mention in passing, are admirably depicted in the Marianne North gallery of paintings at Kew, and most of them may also be seen growing in the large palm house. Including the coconut, nine distinct kinds of palm inhabit these islands, and seven out of the nine have not been found elsewhere. Specially noteworthy among these palms is the double coconut, or coco de mer, *Lodoicea sechellarum*, whose huge, curiously formed fruits were known long before the tree that bears them was discovered. Like the coconut, it has an outer fibrous covering and an excessively hard inner shell. Usually, when divested of its outer covering, it is a two-lobed body, consisting of two oblong lobes side by side. Sometimes it is three, four, or five-lobed, and very rarely six; and then about eighteen inches in diameter. There is a fine series of this singular production in Museum No. 2, at Kew, and young living plants of the palm in the Victoria and palm houses.

It was not until very nearly the middle of the last century that the home of the double coconut was discovered. Previously the nuts had been discovered floating in various parts of the Indian Ocean, and most fabulous accounts of their origin and virtues were given, even by writers of some repute. Among other things the tree was supposed to grow at the bottom of the sea, and enormous prices were paid for the nuts by Asiatic and even some European potentates.

Though not so graceful and elegant as many other palms, the double coconut is a handsome and striking object, having a very slender unbranched trunk, from fifty to a hundred feet high, crowned with a tuft of broad, plaited leaves. The male and female flowers are borne on different individuals, and the nuts hang in clusters at the base of the leaf stalks. It is, or was, common only in Praslin Island, growing singly and in groups on the rocky hills, often almost overhanging the sea.

I will now take the reader to the historically interesting Island of St. Helena, in the Atlantic; a rugged, rocky island, rising nearly three thousand feet above the sea, and having an area of twenty-eight thousand acres. Its isolation is extreme, being upwards of a thousand miles from the coast of Africa, and nearly two thousand miles from the nearest point of the American continent. When first discovered it was entirely clothed with forests, but no mammals of any kind inhabited the island. As was customary in those days, hogs and goats were introduced, in order to provide food for chance visitors in the future. The goats especially multiplied to such an extent that they destroyed the vegetation, or at least prevented seedlings to grow up and replace that removed by decay or felling. The aboriginal vegetation consisted almost entirely of woody plants and ferns, the bulk of the former belonging to the great family *Compositæ*, of which the daisies and asters are familiar examples.

It was not until the beginning of the present century that the island was thoroughly botanized, and it is possible that some of the native plants had already disappeared; at all events, many were already very rare. In 1875 an exhaustive account was published of the condition of the then almost entirely displaced native plants, as well as of the plants that had replaced them. At that date less than half a dozen of the sixty-five certainly indigenous species of flowering plants and ferns collected in the island at the beginning of the century were actually extinct; yet, with the exception of a few scattered individuals, the only remnant of the former flora was high up in the central ridge of mountains and in inaccessible parts of the island. Trees that once covered hundreds of acres were reduced to a few individuals; some to a single example. Large areas once covered with vegetation are now bare, in consequence of the rains having washed the soil from the rocks. In other parts the ground has been completely taken possession of by introduced plants from various parts of the world, prominent amongst which are many British species. Our common furze is now the most abundant shrub in the island, affording employment to many natives, who cut it and take it into the town to be used as fuel. Among trees the British oak is one of the most thoroughly naturalized, growing to a great size and producing acorns in profusion; and the Scotch fir and allied species had been planted to the extent of two hundred acres in 1875. Thus has nearly the whole surface of the island been completely altered; and soon, doubtless, most of the original plants of the island will be extinct, for they exist nowhere else in a wild state, and those in cultivation are difficult to preserve.

Although St. Helena is rather less than fifteen degrees south of the Equator, the general character of the aboriginal flora is not even subtropical. It is like the remains of an intertropical mountain flora, and turning again to Lord Howe Island for comparison, no greater contrast could be found. This island is situated in 31° 30′ S. latitude, yet its vegetation consists largely of tropical types, such as palms, screw pines, banyans, and epiphytal orchids. These differences suggest many interesting deductions, among others a much greater antiquity for the flora of St. Helena.

As already pointed out, a very large proportion of the native plants of such tropical islands as the Seychelles and St. Helena are peculiar to the respective islands, and this holds good for many other islands and groups of islands: the Galapagos and Sandwich groups, for example.

The opposite extreme is found in the numerous coral islands of the Indian and Pacific Oceans, where there are absolutely no endemic or peculiar plants, and the species are nearly all the same, whether we go to the Keeling Islands, six hundred miles off the coast of Sumatra (rendered famous by Darwin's visit some sixty years ago), to the Chagos Archipelago in the centre of the Indian Ocean, or to Caroline Island, upwards of eight thousand miles eastward in the middle of the Pacific. Many of the same plants are also found on continental seashores throughout the tropics, where the conditions are favourable; but to a less degree in the Atlantic than elsewhere. Many of these so-called islands are really atolls, or rings of islets, rising only a few feet above high-water level, and enclosing a central lagoon of varying extent, ranging from a mile

XUM

to fifty miles or more in diameter. A bird's-eye view of one of these atolls from the masthead of a ship is very singular, giving the impression of a circular or oval fringe of vegetation almost on the surface of the ocean. The number of species of plants inhabiting these islands varies from half a dozen to five and twenty, usually representing nearly as many different genera and natural orders as there are species. In some instances the vegetation consists of scattered individuals of herbaceous plants and low bushes; in others of dense thickets, and even forests of trees of considerable size. The coconut palm is usually the most abundant and most conspicuous feature; but how far it owes its presence to human agency is uncertain. There is no doubt that the fruit, like that of almost all the plants associated with it, will bear long immersion in sea-water without injury to the seeds, and seeds that are cast ashore by unusually high seas germinate and grow. It is also known that the Polynesians when visiting uninhabited islands sometimes plant coconut and other seeds. Probably more has been done in this way to spread this useful palm than is generally supposed. Common among the herbaceous plants are a convolvulus, one or two kinds of purslane, and in Polynesia a kind of cress. Screw pines abound in some of the islands; and other trees occasionally occur up to fifty feet in height, with a trunk as much as four feet in diameter.

The natives of these islands subsist almost entirely on coconuts and fish, the latter being extremely abundant in the lagoons.

## EMERY.

By RICHARD BEYNON.

WITH the ordinary uses of emery everyone is familiar. From time immemorial this valuable mineral product has been used in burnishing metals and polishing stones, while during more recent times it has become an essential factor in the machinery of the steel worker or user. Few, however, of those who are thoroughly familiar with the emery paper or the emery hone of everyday life are aware of the interesting story embodied in this useful substance.

The emery of commerce is neither more nor less than an impure form of the mineral corundum. This latter product contains, or should contain, little else than alumina—aluminium and oxygen—and the value of emery depends upon the nearness of its approach to pure alumina. Ordinarily emery contains about seventy or seventy-five per cent. of alumina, the chief remaining constituent, so largely accountable for the dark or reddish-brown colour of emery, being iron oxide.

Emery does not appear to be what may be termed a common mineral, though its geographical range is very extensive. But whether occurrent in ice-bound Greenland, the United States, the Spanish or Scandinavian peninsulas, or the more classic regions of the Eastern Mediterranean or Asia Minor, it is always found in amorphous masses, usually detached blocks associated with gneiss, granular limestone, or other crystalline rocks.

So hard a mineral as is emery can only be quarried with considerable difficulty, and though this is the case the methods employed in the principal European source of emery—Naxos, in the kingdom of Greece—are of the most primitive character imaginable. The mineral is there found in conjunction with hard limestones, and has in great part been forced to or near the surface by igneous upheavals, while aërial and other denuding forces have further assisted in placing large quantities of emery within easy reach of the miners or quarrymen. It is, perhaps, only by a stretch of courtesy that these emery operators can be designated miners or quarrymen, so little is the skill which they show in working the mineral. When a block of emery is discovered, it has to be broken into small portions so as to admit of easier transit to the coast. The means employed to effect this breakage are exceedingly crude and simple, but at the same time not lacking in ingenuity. Fires are lighted round the block so as to materially increase any natural fractures or cracks which the stone may show. Steel levers and wedges are then employed, and in this way the most refractory blocks are reduced to sizeable fragments, which admit of being carried on the backs of mules to the port of debarkation. Inferior, however, as the appliances and plant of these Greek quarrymen may be, the labourers themselves are not without a certain measure of skill in dealing with the emery. The quarries are nominally worked by lessees, who indemnify the Government for the right of exploiting the mines. The quarrymen do not brook importations of non-local labour, their sons succeeding them as labourers at the mines when sufficiently old for the work. There is thus a certain traditional lore extant at the mines, which is looked upon by its possessors as a sort of professional secret and jealously guarded as such. The miners are paid by the lessees according to the output—in fact, they sell the emery to the nominal owners of the mines.

While such primitive methods are employed, it goes without saying that the mines of Naxos are capable of much more effective exploitation. As the surface supply is practically exhausted, it is necessary, of course, to sink shafts in order to reach the mineral, and the *débris* thus excavated is simply dumped on the adjacent bank. Thus it frequently happens that to reach further supplies these heaps have to be subsequently removed, a proceeding necessitating much labour and cost.

In days gone by, when Naxos emery enjoyed a monopoly, such unscientific methods of working did not matter much. Now, however, the inferior emery found in the vicinity of Smyrna is rapidly pushing it from the market. In fact, were not the quality of the emery of Naxos guaranteed by the Greek Government, and none but the best quality allowed to be exported, the emery of Naxos would ere this have disappeared from the markets of the world. In 1848 it commanded over £30 per ton, a price which has now sunk to about one-twelfth of that amount. These prices are those for the port of shipment only, the London merchant charging £4 per ton or thereabouts, according to quality. At present Naxos exports something like four thousand tons per annum. It is shipped like coals, and on arrival at the English or other manufactory is broken, pulverized with stamps, sifted, and then by special processes made into the hones, emery wheels, emery paper, and such things, so necessary to the cutter and glass polisher. Such in brief are some of the more interesting facts relative to emery.

## A CROCODILE MUMMY IN THE BRITISH MUSEUM.

By H. SPENCER.

UNDERGROUND Egypt is continually furnishing us with new light on the religion, manners, and customs of the people who lived in the land of the Pharaohs long before the time of Moses.

The discovery of the Rosetta Stone in 1801 gave fresh impetus to the study of the language known as

hieroglyphic and hieratic; thus, with the facilities for visiting Egypt now available, and the fact that the country is to some extent the foster-child of Great Britain, its history and antiquities are more generally studied. The majestic monuments, gorgeous temples, inscribed obelisks, rolls of papyri, and embalmed bodies in animal and human form, which for centuries baffled the learned and astonished the tourist, have been made to tell their story of battles and victories, arts and sciences, domestic scenes and funeral ritual, which flourished five thousand years ago.

The monumental records and inscriptions in palaces and temples were the principal means by which kings of Egypt perpetuated the record of their deeds of adventure and heroic achievement.

It is the tombs, however, which have preserved to us relics of the life, language, literature, and religion of the people. It is the mode of embalming, the rolls of papyri, the provision of all kinds of domestic furniture which were deposited in the tomb for the use of the soul of the deceased in the future life, which have given us a means of reading anew the story of the life and religion and the part animal worship played in the polytheistic notions of this pious race.

The varied and interesting collection of mummies, mummy cases, and funereal furniture contained in the British Museum has recently been enriched by the acquisition of an enormous crocodile mummy. This creature measures thirteen feet in length, and is well preserved, having a swarm of young crocodiles on its back. Dr. Pritchard, in his "Analysis of Egyptian Mythology," says: "The ancient Egyptians believed that the souls which emanated from the primitive source transmigrated through various bodies; nor was this change confined to emanations of a lower and secondary order. As the souls of men transmigrated through different shapes, so the higher order or spiritual agents could, as occasion required, assume any form they chose; and sometimes the gods appeared in the world under the disguise of bulls, lions, eagles, or other creatures."

This accounts for the vast army of gods, representing so many species in the natural world, which abound in European museums. These were maintained in their day at great expense in sacred parks and lakes, and persons were appointed to nourish them with the greatest care; and, when they died, the same sacred rites were performed over their bodies and the same preparation was made for their interment as if they had been one of the highest functionaries of the state.

The famous fellow that has just been added to our national collection was discovered at Kom-Ombos, in Upper Egypt, a city where this creature was venerated as early as 2500 B.C., and where ruins still remain having paintings relating to the adoration of Sebek. At the south side of one temple the remains of a large pond have been found, which probably served to satisfy the amphibious instinct of this adorable monster. During the reign of Ptolemy Philadelphus, B.C. 330, the worship of the crocodile reached its highest point.

The method employed in making crocodile mummies seems to have varied with taste and means. While some are exquisitely bandaged, others (as in the case of our latest addition) were simply dipped in a solution of wax and pitch, which renders them perfectly hard, and by which the young progeny are securely fixed in the hollow parts of the back.

This is one of the finest specimens of a mummied crocodile that we have seen. It was presented to the British Museum by the Egyptian Government.

## SOME NOTES ON SPIDERS.

By Rev. SAMUEL BARBER.

IN a recent article in KNOWLEDGE (April, 1895) a graphic illustration was given of spiders' pugnacity. This quality is amusingly shown in their conjugal habits; the female so often devouring the male that a species which live together in peace have acquired the special epithet of "benigna" (*Ergatis benigna*).

The instinct of spiders in at once attacking a vital part of their antagonist—as in the case of a theridion butchering a cockroach by first binding its legs and then biting the neck—is most remarkable; but they do not always have it their own way. A certain species of mason-wasp selects a certain spider as food for its larvæ, and, entombing fifteen or sixteen in a tunnel of mud, fastens them down in a paralyzed state as food for the prospective grubs.

Perhaps the most entertaining points in connection with spiders are their concentration of energy, their amazing rapidity of action, and their inscrutable methods of transition and flotation.

During the past autumn large numbers of these creatures appeared at intervals. Thus I observed a vast network of lines that seemed to have descended over the town of Whitstable, in Kent, and which were not visible the day before or the day after. Many were fifteen to twenty feet long; they stretched from house to lamp-post, from tree to tree, from bush to bush; and within six or seven feet of the ground I counted, in a garden, twenty-four or more parallel strands. The rapidity with which spiders work may be gathered from the fact that, while moving about in my room, I found their lines strung from the very books I had, a moment before, been using.

Insect life, as might have been expected after so mild a winter and so dry a spring and summer, is (1896) intensely exuberant. The balance is preserved by a corresponding number of Arachnida. On May 25th and 26th the east wall of the vicarage of Burgh-by-Sands was coated with a tissue of web so delicate that it required a very close scrutiny to detect it. I could find none of the spinners. Every square inch of the building appeared coated with filmy lines, crossing in places, but mostly horizontal, from north to south.

Walking by the edge of a wheatfield in Suffolk on May 14th, I observed all over the path, which was cracked with the drought, dark objects flitting to and fro. They were spiders—mostly of the hunting order. Tens of thousands must have occupied a moderate space of the field, and the cracks in the parched soil afforded them a handy retreat. In reference to the visitation of spiders at Whitstable during the autumn and winter of 1895–6, it is right to note that the people of that place regard them as a sign of an east wind. In this connection we can note the fact of phenomenal clouds of flies occurring at times on the east coast of England; and it would be interesting if observers could ascertain whether spiders ever cross the Channel and accompany such visitations of insects.

The production of the flotation line, and its method of attachment, are the two points to which I ask the attention of observers.

Is it not evident that air (and probably at a high temperature) must be enclosed within the meshes of the substance forming the line when it passes from the spinnerets into the atmosphere? The creature with this substance within its body drops to the ground at once by force of gravitation; yet, when emitted, the very same substance lifts it into the air. It has been usual to explain the ascent by the kite principle, *i.e.*, the mechanical force of the contiguous atmosphere. But air movements, especially on a small scale, are so capricious and un-

XUM

controllable that, without a directive force, the phenomena seem quite inexplicable.

Moreover, all my own observations lead me to accept the theory of a direct propelling force, and I can hardly accept the conclusions on this point of Mr. Blackwall, though he is an authority on the subject. The intense rapidity with which the initial movements are made cannot be reconciled with any theory of simple atmospheric convection; and illustrations such as the following go to prove that spiders possess the faculty of weighting or condensing the ends of their threads, and throwing them, within limited distances, to a point fixed upon.

I was writing, and had two sheets of quarto before me. Perceiving a small spider on the paper I rose and went to the window to observe it. To test its power of passing through air, I held another sheet about a foot from that on which the creature was running. It ascended to the edge, and vanished; but in a moment I saw it landing upon the other sheet through mid-air in a horizontal direction, and picking up the thread as it advanced.

In this case there was no air-movement to facilitate, nor any time to throw a line upward, which, indeed, would not have solved the difficulty. Propulsion appears the only explanation.

The next illustration is more marvellous, and seems to indicate that some species, at any rate, have the power of movement through the air in any direction at will.

Some years ago, at a dinner party in Kent, four candles being lighted on the table, I noticed a thread strung from the tip of one of the *lighted* candles close to the flame, and attached to another candle about a yard off; and all the four lights were connected in this way, and that by a web drawn quite tight. No little surprise was caused among the guests on finding that the diamond form of the web was complete.

No satisfactory explanation of this has been offered, and I can only suggest that the spinner was suspended at first by a vertical line from above, and thus swayed itself to and fro, from tip to tip of the candles. It was certain that the spider could not have ascended from the table; and it was equally certain that aërial flotation of the line from a fixed point was impossible, as it involved floating in four opposite directions. I have seen a creature of this or a nearly allied species moving laterally through the air of a room in this way.

## THE AFFINITIES OF FLOWERS.—THE HAREBELL AND THE DAISY.

By FELIX OSWALD, B.A.Lond.

FEW subjects are more fascinating to the botanist than the investigation of the natural relationships existing between the various orders of flowering plants. Very often these affinities have become so much obscured by later adaptations which have rendered the flower better suited to different surroundings that it is not easy to detect, by mere inspection, its more deeply-seated relations.

For instance, there does not seem, at first sight, to be any resemblance between a harebell and a daisy; but in this paper the attempt will be made to show, by the study of characteristic intermediate types, that the two flowers, externally so dissimilar, may yet be considered to mark the opposite extremes of one and the same series. Of course it is not intended for one moment to infer that the one is directly derived from the other; on the contrary, they stand to each other in the relation of distant cousins, very many times removed, the one having retained to a greater extent the features of the common ancestor, while the other has become more highly specialized in quite a different direction. Keeping this principle in view, we may regard the flowers which are chosen here to bridge over the gap as indicating roughly the various stages from a lower to a higher type of structure. It must, however, be remembered that these transition forms—harebell, rampion, sheep's bit, hemp-agrimony, and daisy—have deviated each more or less from the direct line by reason of adaptation to climate and surroundings as well as to the severe competition to secure a place in nature, but most of all to the requirements of those insects which have (by parallel development) become best fitted to cross-fertilize the particular species.

Everyone is familiar with the delicate drooping blue flower of the harebell, or witch's thimble—a pale blue so perfect as to seem to be the reflection of the sky. Let us now pluck a flower and examine it more closely. The five teeth on the margin of the bell indicate that it is made up of five petals. The bell, however, is not formed by the mere coalescence of the petals by their edges, but by the intercalary growth of the tissue at their bases raising them up. Thus the teeth or lappets alone represent the petals. The body of the bell, as in most tubular flowers, is a new and superadded structure; indeed, in some members of the Campanulaceæ or harebell family—*e.g.*, the sheep's bit—the corolla-tube is so short that at first sight the petals appear to be quite separate from each other (Fig. A).

FIG. A.—Single floret of Sheep's Bit.

When we come to examine the really essential parts of the flower, viz., the stamens and pistil, we find that they present a different appearance according to the age of each flower. Thus, just before the flower bud has opened, the ripe anthers are closely pressed against the immature cylindrical style. The latter is provided with longitudinal rows of small stiff hairs projecting into the anther-cells, which have opened inwardly, facing the style (*i.e.*, are "introrse"). Consequently, as the style grows in length, the pollen is swept out of the anthers by these hairs, and is left adhering to the surface of the style in a broad zone. The stamens, having now fulfilled their purpose, shrivel up and wither. This is the state of things which a newly opened flower presents to view. The style continues to grow longer, and finally

FIG. B.—Section of Harebell at successive stages. I. Stamens depositing pollen on style. II. Stamens shrivelled; stigmas still immature. III. Pollen removed by a bee; stigmas expanded.

expands at its apex into three branches, exposing the stigmatic surfaces, which are sticky, in order to catch and retain the pollen-grains brought from another flower.* (Fig. B, I., II., III.)

A bee visiting a young flower of the harebell will

* The harebell thus furnishes us with a very clear and instructive example of the phenomenon termed "protandry"—that is to say, the anthers reach maturity and shed their pollen before the stigmatic surfaces of the same flower are ready to receive the fertilizing grains. By this means self-fertilization is avoided, and the flower secures, by the agency of winged insects, the advantages arising from being crossed with other flowers of the same species.

inevitably receive on its legs and abdomen some of the pollen adhering to the style, since it uses the style as a support during its search for the honey beneath the spreading bases of the stamens. Subsequently, the bee will visit a rather older flower in which the stigmas are expanded on a level with the entrance to the bell, so that the pollen adhering to the bee's body must necessarily be transferred to the sticky stigmatic surface. But if, after all, the flower should fail to be cross-fertilized by insects, then it takes to self-fertilization as a last resource, and the stigmas curl right back so as to expose their receptive part to the zone of pollen round the style.

In the rampion (*Phyteuma*), another member of the Campanulaceæ, we find indications of an advance on the simpler harebell type. The flowers are no longer on separate stalks, but are collected in heads; we may regard this habit as a step in the direction of economy, for an insect can evidently visit and cross-fertilize a greater number of flowers thus arranged without wasting so much time as if they were each isolated and needing separate visits. The corolla in the rampion is no longer an open bell but a narrow cylindrical tube; the lower part ultimately splits into five ribbons, while the upper part, with a toothed margin, remains a tube for a longer time. The pollen is shed (as in the harebell) by the anthers upon the style within the corolla-tube, and adheres in a broad zone to the lateral collecting hairs. The gradual lengthening of the style, as well as the contraction of the corolla caused by the splitting of the lower part, exposes the zone of pollen for the visits of bees, while the stigma itself remains immature for a day or so longer before unfolding its branches (Fig. C, I.). In the absence of visits from insects,

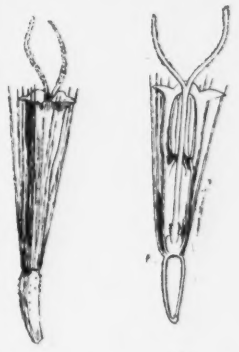
I. II.

FIG. C.—Single floret of Rampion. I. Stigmas immature. II. Stigmas expanded above the zone of pollen.

self-fertilization may, however, occur in the rampion precisely as in the harebell, by the excessive curling back of the stigmatic branches on to the pollen adhering to the style beneath (Fig. C, II.). The presence of an involucre —*i.e.*, a group of floral bracts round the compound flower—as well as the reduction of the stylar branches from three to two, enhances the resemblance to the Compositæ, which has already become foreshadowed by the grouping of the flowers in heads.

In the spherical flower-head of the sheep's bit (*Jasione montana*)—a pretty little blue flower, frequent in mountain districts—the kinship of the flower to the Composite type becomes still more manifest. Here the anthers, instead of being separate from each other, are now "syngenesious"*—that is to say, they are united by their edges, forming a closed ring round the style—but the union is not yet perfect, for only the bases of the anthers have become coherent. The inflorescence, however, is almost identical with that of the Compositæ, for the flowers are crowded together in capitate umbels with involucres, and the stylar branches (as well as the cells of the capsule) have become reduced in number from three to two. Indeed, the similarity is so close that Linnæus himself classed it with the Compositæ.

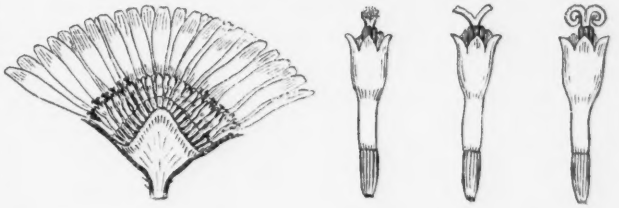
The flowers of these three members of the Campanulaceæ naturally show more affinity between themselves than with the flowers of the usual Composite type. But the gap seems less wide if we consider the structure of one of the more primitive Compositæ, such as the lilac hemp-agrimony (*Eupatorium cannabinum*). Only a few flowers occur in each head, but many of these small heads are grouped together to form a large inflorescence. Moreover, the florets in each little head are not so tightly packed together as in most Compositæ. Each floret presents in the main a similar structure to the more advanced bellflower type, being tubular with five well-marked teeth; but the green calyx becomes reduced here to a number of bristly hairs, and the anthers are now completely united to each other, side to side. However, there is no differentiation as yet into ray and disk-florets; all are alike and all have the same lilac colour. The branches of the style are long and hairy, and as they grow in length they sweep out the pollen from the anthers. Subsequently, when mature, the branches separate widely, exposing the stigmatic surfaces (Fig. D). If the flower fails to be fertilized by insects, then the long curling styles come into contact with the pollen still adhering to the collecting hairs of younger and immature styles of neighbouring florets; thus the florets of the same head become fertilized with each other's pollen.



I. II.

FIG. D.—Single floret of Hemp Agrimony. I. Side view. II. Section.

Finally, the "wee crimson-tipped" daisy (*Bellis perennis*) has carried the differentiation of its flowers to a still greater extreme. Here the florets are of two kinds: white ligulate ray-florets and yellow tubular disk-florets (Fig. E, I.). Moreover, all trace of a calyx, even in the form of hairs or scales, is entirely absent. The ray-florets have become considerably modified from the simple tubular type, which continues to be exemplified in the disk-florets; the lower part of the tube still exists, but the upper part has split open, spreading out into a flat, ligulate (strap-shaped) corolla. But the five minute teeth on the end of the strap betray the parent character. The corolla has been modified in this way chiefly for the sake of making the flower more conspicuous, but also in order to protect the pollen from rain and dew. At night, or when a shower is impending, these flat straps bend over and inwards and effectually cover over the exposed pollen.



I. II. III. IV.

FIG. E.—I. Section of Daisy. II., III., IV., Successive stages in the growth of a disk-floret.

* *Symphyandra*, another member of the Campanulaceæ, has likewise syngenesious stamens.

In this flower, and in most other Compositæ, the pollen is not deposited on a zone round the style, as in the Campanulaceæ, but is set free above its immature tip, which is provided with small stiff hairs. As the style develops and lengthens, this circular array of bristles acts like a chimney-sweep's brush, and pushes in front of it the pollen filling the upper part of the corolla-tube, leaving it on the surface of the flower-head: thus the pollen grains cannot fail, in this exposed position, to come into contact with the abdomen or legs of an insect settling on the flower in search of honey or pollen.

Subsequently, the apex of the style divides into two branches, just like the previous cases, laying bare the receptive surfaces, which up to that moment had been protected by their mutual pressure from contact with pollen from the same floret (Fig. E, I., II., III., IV.).

The differentiation in the daisy of some of the marginal florets into ray-florets, with their characteristic ligulate corolla, has reached a yet higher stage in the large Ligulate section of the Compositæ, some of which possess characteristics of the Campanulaceæ which are wanting in the daisy. Thus, in the pale blue flower-heads of the chicory (*Cichorium intybus*) all the florets are ligulate, but the calyx seems to be a little less degenerate than in most other Compositæ, for it consists of little scales which certainly approach the nature of sepals more closely than the hairs and bristles which usually take the place of the calyx in this order. A striking quality which the chicory tribe possesses, in common with the Campanulaceæ, is the presence of *latex*, or milky juice, in their tissues. Everyone who has plucked a dandelion will be familiar with the appearance of the dense white juice welling up from the wound; and it is highly probable that this forms another of the characteristics which the two groups of plants derive from a remote common ancestor.

To sum up: the points in which the Compositæ resemble the Campanulaceæ are the following:—

1. The valvate æstivation of the corolla—*i.e.*, the petals in the flower-bud are placed edge to edge, and do not overlap in any way.
2. The occurrence of inulin (Dahlia, Jerusalem artichoke) and of latex (chicory, dandelion).
3. The ovary is inferior to the corolla. This condition always points to the flower having reached a high state of development.
4. The tendency in some of the Campanulaceæ for the anthers to adhere by their sides to form a tube, becomes a general rule in the Compositæ. In *Eupatorium* the pollen is shed on to the lateral surface of the style as in Campanulaceæ, although in most Compositæ it is discharged above the tip of the style.
5. The phenomenon of protandry as explained above.
6. The ovule is anatropous—*i.e.*, the ovule, though straight itself, is bent on its own stalk so that the micropyle (the pore through which the pollen-tube penetrates) is close to the place where the ovule is attached to the placenta.

It still remains necessary to give some explanation of the differences between the two orders. These, although of importance, do not, I think, present any insuperable difficulties.

The Campanulaceæ differ from the Compositæ in the following particulars:—

1. The arrangement of the veins in the corolla.
2. The plurality and horizontal direction of the ovules. (In the Compositæ there is only one ovule in the ovary, and it is erect.)
3. The fruit in Campanulaceæ is a capsule with two or three divisions, and not an achene.
4. The collecting hairs on the style are arranged in lines and not in a ring.
5. The seed contains endosperm.
6. The prevailing colour of the flowers is blue, while that of the Compositæ is yellow.

Most of these differences (2, 3, and 5) result from the crowding together of great numbers of flowers into compact heads. In all such cases the number of ovules tends to become reduced. Moreover, the fact that there are two stigmatic branches to the style in Compositæ seems to indicate that their ancestor possessed an ovary with two loculi or compartments, just as in the rampion and sheep's bit. And, furthermore, the suppression of endosperm in the seeds of the Compositæ is not, after all, a hard-and-fast distinction between the two orders, for the seed of *Tagetes*, a Composite plant, still contains some endosperm, and can therefore be termed albuminous.

The other points hardly seem to constitute deep-seated differences in the essential structure of flowers, but may be regarded rather as superficial and responsive adaptations to secure fertilization by different insects or to differences in the climatic surroundings.

But the question will very naturally arise, "If the Compositæ are descended from an ancestral type somewhat like the harebell, how is it that the prevailing colour of Composite flowers is yellow, while nearly all the Campanulaceæ have blue flowers?"

To this question, Grant Allen, in his "Colours of Flowers" (pp. 81-85), has suggested a very plausible and ingenious answer, the gist of which I venture to reproduce as an extremely probable solution of the difficulty. Observation of analogous cases (Rubiaceæ, etc.) tends to show that when flowers with highly specialized colours, such as blue, become dwarfed and crowded together, they show a tendency to revert through lilac, pink, and white back again to the more primitive yellow. This retrogression in colour is probably due to the fact that the crowded florets are no longer dependent on the visits of only one species of insects to secure cross-fertilization, and hence the reversion in many flower-heads to the yellow of their distant ancestors, since it is the colour which appeals to a great number of miscellaneous insects. In accordance with this principle, Grant Allen considers that "the primitive ancestral Composite had reached the stage of blue or purple flowers while it was still at a level of development corresponding to that of the sheep's bit (*Jasione*)." Thus the Cynaroid or thistle group of the Compositæ are all purple or blue, and the florets are fairly large. In the group of the Corymbifers yellow becomes general; but the least evolved type, the hemp-agrimony, is still purple. Yet, while in many members of the group both ray-florets and disk-florets are a uniform yellow, the daisy shows evidence of a progressive step in its development of colour, for not only are the ray-florets white, but their edges have begun to show signs of pink. Lastly, the delicate blue colour of the chicory may perhaps indicate a similar forward development, which in this plant has reached the higher notes of the scale of colour.

The Compositæ have often been bracketted together with the Teasel tribe, the Dipsacaceæ, and even a genetic connection between them has sometimes been assumed. But when we come to balance all the facts of the case, this alliance is more apparent than real. It would take too long in this article to dwell upon the technical but essential differences which distinguish the Dipsacaceæ from the Compositæ, such as the presence of an epicalyx, a simple style and a terminal undivided stigma, the imbricate æstivation of the corolla, the stamens being only four in

number, the pendulous ovule, etc.; but it is perhaps sufficient to state that there is satisfactory evidence to show that they form the final stage in the series Rubiales-Dipsacales, and hence are not really related to the Compositæ, but have arrived by a different path at somewhat analogous structures. Similar capitate inflorescences are likewise to be found in the final stages of other lines of descent, as in the sea-holly (*Eryngium*) among the Umbelliferæ.

## THE FACE OF THE SKY FOR SEPTEMBER.

By HERBERT SADLER, F.R.A.S.

THE number of spots diversifying the solar disc is still very small.

A conveniently observable minimum of Algol will occur at 10h. 50m. P.M. on the **8th**.

Both Mercury and Venus are too near the Sun this month for the observer's purposes, and Jupiter does not rise till after midnight at the end of the month.

Mars is an evening star, and is now a fine object in the evening. On the **1st** he rises at 9h. 46m. P.M., or 3h. 2m. after sunset, with a northern declination of 20° 53′, and an apparent equatorial diameter of 9⅓″, the defect of illumination on the preceding limb amounting to 1·4″. On the **9th** he rises at 9h. 28m. P.M., with a northern declination of 21° 35′, and an apparent equatorial diameter of 10·0″. On the **16th** he rises at 9h. 12m. P.M., or about 3h. 2m. after sunset, with a northern declination of 22° 6′, and an apparent equatorial diameter of 10½″, the defect of illumination on the preceding limb amounting to 1½″. On the **23rd** he rises at 8h. 54m. P.M., or 3h. after the Sun, with a northern declination of 22° 27′, and an apparent equatorial diameter of 11·0″. On the **30th** he rises at 8h. 35m. P.M., or 2h. 57m. after the Sun, with a northern declination of 22° 52′, and an apparent diameter of 11⅓″, the phasis on the preceding limb amounting to 1⅓″. He is in conjunction with Neptune at 6h. A.M. on the **24th**, Mars being 50′ to the north. During the month he describes a direct path in Taurus, almost to the confines of Gemini.

Saturn is an evening star, and is still visible shortly after sunset during the first half of the month. On the **1st** he sets at 8h. 55m. P.M., or 2h. 11m. after the Sun, with a southern declination of 14° 4′, and an apparent equatorial diameter of 30″ (the major axis of the ring system being 37½″ in diameter, and the minor 13½″). On the **7th** he sets at 8h. 34m. P.M., or about two hours after the Sun, with a southern declination of 14° 13′, and an apparent equatorial diameter of 30″ (the major axis of the ring system being 37⅓″ in diameter, and the minor 13⅓″). On the **16th** he sets at 7h. 58m. P.M., or 1h. 45m. after the Sun, with a southern declination of 14° 28′, and an apparent equatorial diameter of 29¾″ (the major axis of the ring system being 37″ in diameter, and the minor 13″). He describes while visible a short direct path in Libra.

Uranus is too near the Sun to be conveniently observed.

Neptune is an evening star, rising on the **1st** at 9h. 50m. P.M., with a northern declination of 21° 42′, and an apparent diameter of 2·6″. On the **30th** he rises at 8h. 30m. P.M., with a northern declination of 21° 41′. He is almost stationary in Taurus during the month.

There are no very well marked showers of shooting stars in September.

The Moon is new at 1h. 43m. P.M. on the **7th**; enters her first quarter at 4h. 10m. P.M. on the **14th**; is full (Harvest Moon) at 10h. 49m. P.M. on the **21st**; and enters her last quarter at 1h. 58m. A.M. on the **30th**. She is in perigee at 8h. P.M. on the **8th** (distance from the Earth, 223,420 miles), and in apogee at 3h. A.M. on the **24th** (distance from the Earth, 252,400 miles). The Moon will pass through the Pleiades on the evening of the **26th**, occulting several of the bright stars in that asterism.

## Chess Column.

By C. D. LOCOCK, B.A.Oxon.

**Communications for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 10th of each month.**

*Solutions of August Problems.*

(A. C. Challenger.)

No. 1.

1. Q to B7, and mates next move.

No. 2.

Key move.—1. Kt to K5.

| | | |
|---|---|---|
| If 1. . . . | K × P, | 2. R × Pch, etc. |
| 1. . . . | P × Kt, | 2. B × P, etc. |
| 1. . . . | R or Kt moves, | 2. R to QKt5ch, etc. |
| 1. . . . | P × P, | 2. R to Kt5ch, etc. |
| 1. . . . | B to Kt7, | 2. Kt(K5) to KB3, etc. |

[It will be noticed that though there is a double threat, Black is cleverly compelled to defend himself against at least one of the threats.]

CORRECT SOLUTIONS of both problems received from Alpha, Arthur S. Coulter, A. G. Fellows, H. S. Brandreth (Dresden), H. Le Jeune, G. A. F. (Brentwood), and W. Willby. Of No. 1 only from G. G. Beazley and A. E. Whitehouse.

*Hubert Price.*—In the amended position the key is doubly weak, because (i.) it shuts out the Black King from his only available square; and (ii.) the piece moved is *en prise*. A remedy would be to omit the first move, and publish the position as a simple three-mover; but the idea, we fear, is one that has been often represented before.

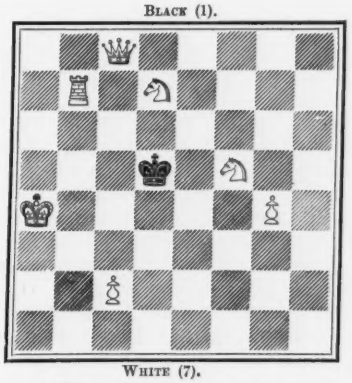
*S. J. Charleston.*—In the position you send you appear to have overlooked the defences Kt to B7 or Ksq or Q4, preventing mate. In any case, we should say the idea is not suitable for a problem.

PROBLEMS.

By C. D. Locock.

No. 1.

BLACK (1).

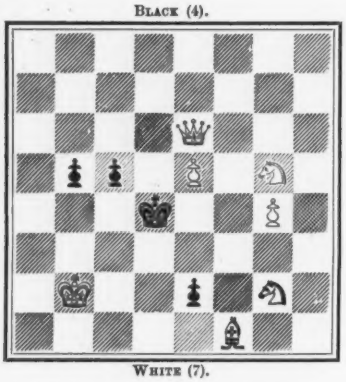


WHITE (7).

White mates in two moves.

No. 2.

BLACK (4).



WHITE (7).

White mates in two moves.

## CHESS INTELLIGENCE.

The event of last month was the International Tournament at Nuremburg. There were nineteen competitors, each playing one game a day as far as possible, though, owing to the odd number of players, there was necessarily a bye every day. The list of players differed only in one instance from that given last month, M. Charousek taking the place of Mr. Burn. Other notable absentees were Lipke, Makovez, Englisch, Weiss, Bird, Mason, Gunsberg, Mieses, Lipschütz, and Bardeleben.

The players came out in the following order :—

| | | Won. | Drawn. | Lost. | Total. |
|---|---|---|---|---|---|
| FIRST PRIZE ... | E. Lasker ... | 12 | 3 | 3 | 13½ |
| SECOND PRIZE | G. Maroczy ... | 8 | 9 | 1 | 12½ |
| THIRD / FOURTH PRIZES | H. N. Pillsbury | 10 | 4 | 4 | 12 |
| | Dr. Tarrasch | 9 | 6 | 3 | 12 |
| FIFTH PRIZE ... | M. Janowski... | 10 | 3 | 5 | 11½ |
| SIXTH PRIZE ... | W. Steinitz ... | 10 | 2 | 6 | 11 |
| SEVENTH PRIZE | C. Schlechter | 5 | 11 | 2 | 10½ |
| | C. A. Walbrodt | 7 | 7 | 4 | 10½ |

The other scores in order being : Schiffers and Tchigorin, 9½ ; Blackburne, 9 ; Charousek, 8½ ; Marco, 8 ; Albin, 7 ; Winawer, 6½ ; Showalter, 5½ ; Porges, 5½ ; Schallopp, 4½ ; and Teichmann, 4. Mr. Blackburne obtained the Special Prize for the best score against the prize-winners.

Mr. Lasker won rather more easily than his score indicates. Nothing depended on his last game with Charousek, otherwise he would probably have contrived at least not to lose it. His position and that of Tchigorin confirms the result of the St. Petersburg quadrangular tournament. Pillsbury and Steinitz reversed their respective positions, but the result depended on the last game played. Pillsbury started badly ; but among his later victims were Lasker, Tarrasch, Tchigorin, and Steinitz, the four of greatest repute among his opponents.

Maroczy's was a very fine and rather unexpected performance. He is twenty-six years of age, and has only played chess two or three years, we believe, so that he is not unlikely to succeed in his turn to the championship. It will be seen that he lost only one game out of the eighteen. Dr. Tarrasch, who may have been handicapped somewhat by the cares of management, recovered from an indifferent start, and was as steady as usual. Janowski at one time looked like being second, but he went to pieces at the finish—the fate also of Walbrodt. Steinitz succeeded in avoiding the draw with his usual skill, but too often at the expense of a loss. One does not expect the veteran champion to lose so large a proportion of his games as one-third. Schlechter, as usual, drew most of his games. His score is quite a curiosity ; he and Walbrodt will always come out halfway down the list in any tournament, with Marco, the other drawing master, a little below them. Schiffers came out in his right place, but Tchigorin should have been equal to the seventh prize. Blackburne started badly, but afterwards did well, especially against the prize-winners. Charousek is an unknown player who made a brilliant *début ;* and Albin, another brilliant but uncertain player, made a creditable score. Showalter, the American, came out in his right place ; but the veterans Winawer, Schallopp, and Porges are clearly past their prime. The action of the Hastings committee in reluctantly giving younger men the preference over them last summer seems to be vindicated by their present performances. Teichmann's position is a great surprise, especially after his victory in the Divan Tourney had shown him to be in good form. No doubt ill-health or some similar cause may account for his poor score. It is rather remarkable that the three representatives of "English" chess came out one first, another last, and the third as nearly as possible halfway down the list. Also noteworthy is the fact that Steinitz, as at Hastings, lost to Janowski, Lasker, Pillsbury, and Tarrasch. He was also the only player who beat Maroczy, and one of the two who beat Schlechter, the other being Janowski.

### CONTENTS OF No. 130.


| | PAGE |
|---|---|
| Hygroscopic Seeds. By Rev. Alex. S. Wilson, M.A. B.Sc. (*Illustrated*) | 169 |
| The Lime. By Geo. Paxton. (*Illustrated*) | 171 |
| English Coins.—II. By G. F. Hill, M.A. | 172 |
| Appreciation of Musical Pitch. By Dr. J. G. McPherson, F.R.S.E. | 175 |
| Waves.—VIII. Capillary Waves. By Vaughan Cornish, M.Sc. (*Illustrated*) | 176 |
| An Expedition to Discover how Coral Islands Grow. By E. W. Richardson | 178 |
| Science Notes | 179 |
| Notices of Books. (*Illustrated*) | 179 |
| Letters :—H. A. Cookson ; Rev. C. Robinson, B.A. ; A Landsman ; H. P. Curtis ; J. Creagh | 181 |
| Note on a Photograph of the Nebula M 8 in Sagittarius. By Prof. Kavasjee D. Naegamvala, M.A., F.R.A.S. | 183 |
| Stock-Taking of the Variable Stars. By Lieut.-Colonel E. E. Markwick, F.R.A.S. (*Illustrated*) | 183 |
| Our Fur Producers.—IV. Fur Seals. By R. Lydekker, B.A., Cantab., F.R.S. (*Illustrated*) | 186 |
| How to Observe an Earthquake. By Charles Davison, Sc.D., F.G.S. | 189 |
| The Face of the Sky for August. By Herbert Sadler, F.R.A.S. | 191 |
| Chess Column. By C. D. Locock, B.A.Oxon. | 191 |


TWO PLATES.—1. English, Scottish, and Irish Coins. 2. M 8 Sagittarii.


## *NOTICES.*

The numbers of KNOWLEDGE for January and February of 1894 can now be had, price One Shilling each.

Bound volumes of KNOWLEDGE, New Series, can be supplied as follows :—Vols. I., II., III., and VIII., 10s. 6d. each ; Vols. VI., VII., IX., and X. (1895), 8s. 6d. each.

Binding Cases, 1s. 6d. each ; post free, 1s. 9d.

Subscribers' numbers bound (including case and Index), 2s. 6d. each volume.

Index of Articles and Illustrations for 1891, 1892, 1894, and 1895 can be supplied for 3d. each.

## *TERMS OF SUBSCRIPTION.*

ANNUAL SUBSCRIPTION, 8s., POST FREE.

"KNOWLEDGE" as a Monthly Magazine cannot be registered as a Newspaper for transmission abroad. The terms of Subscription per annum are therefore as follows :—To any address in the United Kingdom, the Continent, Canada, United States, Egypt, India, and other places in the Postal Union, the Subscription is 8 shillings, including postage ; or 2 dollars ; or 8 marks ; or 10 francs.

For all places outside the Postal Union, 6 shillings in addition to the postage.

Communications for the Editors and Books for Review should be addressed Editors, "KNOWLEDGE" Office, 326, High Holborn, London, W.C.